Studies of the Macrochires, Morphological and otherwise, with the view of indicating their Relationships and defining their several Positions in the System.

By R. W. Shufeldt, M.D., C.M.Z.S., Captain, Medical Corps, U.S. Army. (Communicated by W. K. Parker, F.R.S., F.L.S.)

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(Plates XVII.–XXIV.)

It may be remembered by those who are interested in the structure and classification of birds that I published, in the 'Proceedings' of the Zoological Society for 1885 (pp. 886–915), a memoir entitled "A Contribution to the Comparative Osteology of the *Trochilidæ, Caprimulgidæ,* and *Cypselidæ.*" That memoir professed to be but little more than a mere introduction to a subject which I will here enter upon more fully, although the opinions there set forth are, in the main, substantially those that I still hold, at least in the case of the *Trochilidæ* and *Caprimulgidæ.* Since the date of that paper, however, I have never ceased in my endeavour to gather together the necessary material for this, my second contribution on the subject; and, as will be seen by the list of specimens in the subjoined Table, these efforts have met with a very fair measure of success.

In the conclusions at the close of my former paper I contended that all the existing Caprimulgine birds of the world's avifauna should be grouped in one order, the Caprimulgi. In this group, no doubt, would fall *Nyctibius* and *Steatornis*, and very probably *Podargus* and *Psalurus.* Further, I proposed that the Humming-birds should constitute another order, to be known as the Trochili. I made no final determinations in regard to the Swifts, beyond that they should be separated from the Trochili; but these birds will be carefully studied in the present memoir, and my opinions in regard to them stated in the conclusions which close it.

Finally, I had something to say about certain apparent resemblances between the bones in the roof of the mouth of a Trogon and the corresponding structures in a Humming-bird. But my remarks were only drawn from a paper by W. A. Forbes published in the 'Proceedings' of the Zoological Society three or four years previous to my quoting them*, and at the time I had not had an opportunity of personally examining the skeleton of a Trogon. In the present paper, however, the case will, in this respect, be different; for, thanks to the kindness of Dr. P. L. Sclater, I have been enabled to study in this connection the skeletons of two different species of Trogon, which he has obligingly lent me for the purpose. For other material I am under obligations to a number of friends, to whom I here desire to express my sincere thanks; and I believe it will be found that in the proper column of the Table below I make due acknowledgments, by entering the names of the several donors opposite the specimens they have been so good as to send me. Indeed, had it not been for their kind and ready assistance, it would have been impossible for me to have completed the present work. Such material as I have been enabled to collect myself is also set forth in the Table in question. My thanks are further due to the Editors of 'The Auk' and of 'Forest and Stream,' for kindly inserting for me requests for specimens of birds in alcohol to be used in the present connection.

Glancing over this list of material, it will be observed that, so far as the ordinary forms of the American Caprimulgine birds are concerned, it admits of giving a full account of their structure. The skeleton in these also may be conveniently compared with the skeleton in the two species of Trogons likewise represented; and these latter with other types presented in the Table, as well as with such a skeleton as is presented in *Geococcyx californianus*, which I have elsewhere studied (Journ. Anat. and Phys. Lond. vol. xx. 1886, pp. 244–266) and published an account of its characters.

Similarly, we find the North-American CYPSELI very well represented, the only important form not found among my material being *Cypseloides niger*, and all my efforts to secure specimens in alcohol of this interesting Swift have utterly failed †. In my first contribution to the anatomy of these birds (P. Z. S. 1885, p. 886), I advanced the opinion that they were but profoundly modified Swallows, and should not be grouped with the Trochili in our classification of birds. We now have the opportunity

* Forbes, W. A., "Note on the Structure of the Palate in the Trogons (*Trogonidæ*)," P. Z. S. 1881, p. 836.

† I have since received alcoholic specimens of this form from my friend Prof. A. Newton, F.R.S., who kindly procured them from Jamaica for me.

of ascertaining how this opinion will stand the test of more extensive researches into their structure, with the aid of a far better supply of material than I was enabled to handle upon the first occasion.

The Table also presents a very fine collection of skeletons and specimens in alcohol of the Trochili; and the structure of these, as I say, will in the following pages be thoroughly compared with the corresponding structures to be found in the Swifts.

It is further my intention to compare the Swifts thoroughly with the Swallows; and to this end I find that I have examples of every genus of the latter birds, as they are represented in the North-American or, rather, United States avifauna. Up to the present time my efforts to secure specimens in alcohol of such a form as *Hemiprogne zonaris* have not succeeded; but Mr. C. B. Cory has kindly written for me to some collectors in the West Indies, and I have taken the liberty to apply for some of these birds to the governmental authorities in Jamaica. Sufficient time has scarcely elapsed for me to have received replies, but I am under the impression that when this type comes to be compared with more typical Swifts, some light will be thrown upon the present subject.

Finally, it is my intention in this memoir to review some of the structural and other characteristics of the *Passeres*; not that the majority of the ordinary ones are not already known to us, but rather to have them arranged systematically at hand, for comparison in the present connection. I have chosen for this purpose a specimen of *Ampelis garrulus*, being influenced in my choice more particularly by the fact that, although it happens to be Passerine, it is not strictly and typically so: moreover, some ornithologists apparently recognize in it certain Swallow-like characters, more especially those which have a certain resemblance to such a bird as *Progne subis*, which it appears to approach in the form of the bill. Others, and much earlier authorities, have entertained the notion that the Waxwings belong rather to the *Clamatores*, being probably related to the *Tyrannidæ*, and should be placed near them. So that, on the whole, I trust that, in addition to meeting other ends in view, a glance at the structure of this strictly American representative of the *Ampelinæ* will not come amiss.

The order in which I propose to present the material to be examined will be:—first, a sketch of the morphology of

Table, showing the Material examined in this Memoir, and the Sources from whence it was obtained, and its Character.

Specimens, Age and Sex.	No. of specimens examined.	Collector's Name.	Donor's Name.	Locality and Date.	Remarks.
Trogon mexicanus	1	Unknown	P. L. Sclater	V. de Fuego, Guatemala.	Complete skeleton.
T. puella	1	Unknown	P. L. Sclater	V. de Fuego, Guatemala.	Complete skeleton.
Antrostomus vociferus, ad., ♂	1	Unknown	Jno. H. Sage	Portland, Ct.; Aug. 12th, 1886.	In alcohol.
Phalænoptilus Nuttalli, ad., ♂	1	R. W. Shufeldt	....	Fort Wingate, New Mexico; July 12th, 1885.	Complete skeleton.
P. Nuttalli, ♂	1	R. W. Shufeldt	....	Fort Wingate; July 12th, 1885.	Incomplete skeleton.
Chordeiles virginianus	1	Purchased	....	Near Chicago, Ill.; July 1886.	Adult: in alcohol.
C. virginianus, var. *Henryi*	3	R. W. Shufeldt	....	Fort Wingate, N. Mexico; June 1886.	Adults: in alcohol.
C. virginianus, var. *Henryi*	1	R. W. Shufeldt	....	Fort Wingate; July 1886.	Adult: skeleton.
C. texensis	1	R. W. Shufeldt	....	Fort Wingate; June 1886.	Adult: in alcohol.
C. texensis	1	R. W. Shufeldt	....	Fort Wingate; June 1886.	Adult: skeleton.
Chætura pelagica, adults	2	G. S. Miller, Jun.	G. S. Miller, Jun.	Peterboro', N.Y.; July 19th, 1886.	Complete skeletons.
C. pelagica	2	Luther N. Rossiter	Luther N. Rossiter	Lake Forest, Illinois; July 10th, 1886.	Adults, ♂ and ♀, in alcohol, a mated pair, taken with a net.
C. pelagica, adults	4	G. S. Miller, Jun.	G. S. Miller, Jun.	Peterboro', N.Y.; July 19th, 1886.	In alcohol.
C. pelagica, adults, ♂ & ♀	4	A. K. Fisher	A. K. Fisher	Sing Sing, N.Y.; June and July 1886.	In alcohol.

Micropus melanoleucus, adult, ♂.	1	R. W. Shufeldt ……	……………	Fort Wingate, N. Mexico; April 23rd, 1885.	Complete skeleton.
M. melanoleucus, adult………	1	R. W. Shufeldt ……	……………	Fort Wingate; Sept. 1885.	In alcohol.
M. melanoleucus, adult………	1	R. W. Shufeldt ……	……………	Fort Wingate; June 1886.	In alcohol.
M. melanoleucus, adults ……	5	R. W. Shufeldt ……	……………	Fort Wingate; Sept. 8th, 1886.	In alcohol.
M. melanoleucus, adults ……	10	R. W. Shufeldt ……	……………	Fort Wingate; Sept. 11th, 1886.	Nine in alcohol, and one trunk taken from a skin.
Cœligena clemenciæ, adult, ♂	1	F. Stephens ………	F. Stephens ………	S. C. Mts., Arizona Terr.; May 14th, 1884.	Sternum and shoulder-girdle.
Trochilus colubris, adult, ♀…	1	H. K. Coale ………	H. K. Coale ………	Tollestone, Ind.; Aug. 5th, 1884.	In alcohol.
T. colubris, adults, ♂ & ♀ …	2	G. S. Miller, Jun. …	G. S. Miller, Jun. …	Peterboro', N.Y.; May 21st, 1886.	In alcohol.
T. colubris, adults, ♂ & ♀ …	2	G. S. Miller, Jun. …	G. S. Miller, Jun. …	Peterboro', N.Y.; May 23rd & 25th, 1886.	Skeletons.
T. colubris, adults, ♂ & ♀ …	2	Jno. H. Sage ………	Jno. H. Sage ………	Portland, Ct.; July 12th & 13th, 1886.	In alcohol.
T. colubris, juv., ♂ …………	1	Jno. H. Sage ………	Jno. H. Sage ………	Portland, Ct.; July 23rd, 1886.	In alcohol.
T. Alexandri, adult, ♂ ……	1	R. W. Shufeldt ……	……………	Fort Wingate, N. Mexico; April 23rd, 1885.	Skeleton.
T. Anna, adults, ♀ …………	2	W. O. Emerson ……	W. O. Emerson ……	Haywards, Cal.; May and June 1886.	In alcohol.
T. Anna, juv. ♂, ad. ♂ ……	2	F. Stephens ………	F. Stephens ………	San Barnardino, Cal.; Sept. 27th, 1884.	Sterna and shoulder-girdles.
T. platycercus, adult, ♂ ……	1	F. Stephens ………	F. Stephens ………	San Bernardino, Cal.; July 28th, 1884.	Sternum and shoulder-girdle.
T. platycercus, adults, ♂ & ♀	2	R. W. Shufeldt ……	……………	Fort Wingate, N. Mexico; June 12th, 1886.	In alcohol.
T. platycercus, adult, ♂ ……	1	R. W. Shufeldt ……	……………	Fort Wingate; Aug. 13th, 1886.	In alcohol.

Table (*continued*).

Specimens. Age and Sex.	No. of specimens examined.	Collector's Name.	Donor's Name.	Locality and Date.	Remarks.
Trochilus rufus, adults, ♂ & ♀.	12	R. W. Shufeldt	....	Fort Wingate, N. Mexico; August 1886.	In alcohol.
T. rufus, adults & juv., ♂ & ♀	13	R. W. Shufeldt	....	Fort Wingate; August 1886.	Skeletons.
T. Calliope, adults, ♂ & ♀...	2	F. Stephens............	F. Stephens	San Bernardino, California.	Sterna and shoulder-girdles.
T. Calliope, juv.	2	F. Stephens............	F. Stephens	San Bernardino, Cal.; May 24th, 1885.	In alcohol: nestlings.
T. Calliope, ♂, ♀, & juv. ...	12	R. W. Shufeldt	....	Fort Wingate, N. Mexico; Aug. 1886.	In alcohol.
T. Calliope, adults, ♂	3	R. W. Shufeldt	....	Fort Wingate; Aug. 1st, 1886.	Skeletons.
Iache latirostris, adult, ♀ ...	1	F. Stephens............	F. Stephens	S. K. Mts., Arizona Terr.; June 12th, 1884.	Sternum and shoulder-girdle.
Progne subis, adult, ♀	1	R. W. Shufeldt	....	Fort Wingate, N. Mexico; June 15th, 1886.	Skeleton.
P. subis, adult, ♀	1	A. K. Fisher	A. K. Fisher	Sing Sing, N.Y.; June 29th, 1886.	In alcohol.
P. subis, adults, 1 ♂ & 2 ♀...	3	R. W. Shufeldt	....	Fort Wingate, N. Mexico; June 1886.	In alcohol.
Petrochelidon lunifrons, juv...	1	R. W. Shufeldt	....	Fort Fetterman, Wyo.; June 1886.	Incomplete skeleton.
P. lunifrons, adults, ♂	2	R. W. Shufeldt	....	Fort Wingate, N. Mexico; July 16th, 1886.	Complete skeletons.
P. lunifrons, adults	2	R. W. Shufeldt	....	Fort Wingate; June 1886.	In alcohol.

Chelidon erythrogaster, adult, ♂.	1	R. W. Shufeldt ……	R. W. Shufeldt ……	Fort Wingate; July 16th, 1886.	Complete skeleton.
C. erythrogaster, juv., ♂ ……	1	R. W. Shufeldt ……	……………	Fort Wingate; June 1885.	In alcohol.
C. erythrogaster, adults, ♂ …	2	R. W. Shufeldt ……	……………	Fort Wingate; June 1886.	In alcohol.
C. erythrogaster, juv., ♀ ……	1	R. W. Shufeldt ……	……………	Fort Wingate; Sept. 11th, 1886.	In alcohol.
C. erythrogaster ………………	1	H. K. Coale ………	H. K. Coale ………	Chicago, Ill.; Aug. 20th, 1886.	In alcohol.
Tachycineta bicolor, adult …	1	G. S. Miller, Jun. …	G. S. Miller, Jun. …	Peterboro', N.Y.; April 26th, 1886.	In alcohol.
T. thalassina, adults…………	3	R. W. Shufeldt ……	……………	Fort Wingate, N. Mexico; July 1885.	Skeletons.
T. thalassina, adults…………	3	R. W. Shufeldt ……	……………	Fort Wingate; June 1886.	In alcohol.
Clivicola riparia, adults ……	4	E. M. Hasbrouck …	E. M. Hasbrouck …	Port Byron, N.Y.; Aug. 7th, 1886.	Two in alcohol; two skeletons.
C. riparia, 1 adult and 4 nestlings.	5	Luther N. Rossiter…	Luther N. Rossiter…	Lake Forest, Ill.; July 10th, 1886.	In alcohol.
C. riparia, adults ……………	3	H. W. Henshaw……	H. W. Henshaw……	Washington, D.C.; July 10th, 1886.	In alcohol.
C. riparia, adults ……………	2	J. G. Parker …… …	J. G. Parker ………	Chicago, Ill.; Aug. 19th, 1886.	In alcohol.
Stelgidopteryx serripennis, adult.	1	G. S. Miller, Jun. …	G. S. Miller, Jun. …	Peterboro', N.Y.; May 7th, 1886.	In alcohol.
S. serripennis, adult …………	1	H. W. Henshaw……	H. W. Henshaw …	Washington, D.C.; July 10th, 1886.	In alcohol.
Ampelis garrulus, adult, ♀…	1	R. W. Shufeldt ……	……………	Fort Fetterman, Wyo.; 1879.	Incomplete skeleton.
A. cedrorum, adult, ♂………	1	H. K. Coale ………	H. K. Coale ………	Chicago, Ill.; Aug. 20th, 1886.	In alcohol.

Ampelis cedrorum; secondly, a study of the osteology of *Trogon mexicanus* and *T. puella*; thirdly, an examination of the structure of a number of the CAPRIMULGI; fourthly, an investigation of the anatomy of the North-American *Hirundinidæ*; fifthly, similar inquiries into the morphology of certain CYPSELI and TROCHILI, including extensive comparisons with the facts brought out in the first sections of the paper; and, lastly, a section devoted to my final Comparisons and Conclusions.

THE MORPHOLOGY OF AMPELIS CEDRORUM.

From an external examination of the subject, we find that the following characters are presented:—

1. The soft feathers on the top of the head unite to form a conspicuous crest.

2. The bill is broad at its base, rather short, and vertically compressed; while both mandibles show a distinct notch at the sides near the apices.

3. The cleft of the gape extends nearly as far back as the anterior arc of the eyelids.

4. The nostrils are subelliptical and scaled.

5. The wings are ample, pointed by the 3rd primary of the 10 composing one of them, the 1st primary being rudimentary.

6. Peculiar wax-like prolongations of the shaft are found in certain of the wing-feathers, and in some individuals in the tail-feathers.

7. Tail very slightly rounded, and composed of 12 rectrices.

8. Lateral plates of tarsus subdivided, with the anterior portion of this envelope composed of six distinct scutes.

9. Feet moderately strong, and characterized by having the basal phalanges of middle and outer toes more or less united.

10. In form, the body is somewhat robust and full-chested.

To this we may add that the Cedar-bird builds its nest upon trees, and lays spotted eggs, and that the young have a different coloration of plumage from their parents, which, in this respect, are alike.

On plucking the specimen the following additional characters are revealed:—

11. The pterylosis agrees almost exactly in pattern with the pteryloses of the majority of Passerine birds. *A. cedrorum* has, however, a lateral and narrow tract running longitudinally down

each side of the neck; these connect the humeral tracts with the feathering of the head.

Otherwise both the dorsal and ventral tracts of the Cedar-bird agree very well with the details of this important character as seen in such a Passerine form, *e. g.*, as *Motacilla alba.* This fact may be better appreciated by comparing my drawings of the former (Pl. XVII. fig. 1 *a* & *b*) with Nitzsch's figures of the pterylosis of the latter *.

12. The oil-gland is found to be nude, and this gland has a form such as is assumed among the great majority of the *Passeres.*

Upon removing the integument, one of the most convenient anatomical points to be first examined is the method of insertion of the muscles of the patagium. In the case of a small bird such as we have in *Ampelis*, our present subject, I find an easy way to do this is to seize the elbow of the plucked pectoral limb with the thumb and index finger of the left hand, in such a manner that the palmar surface of the index finger is applied to the under surface of the patagium, and keeps it on the stretch. The thumb is opposed to this, and firmly holds the elbow-joint, and no more. We now make an incision, with the scalpel in our right hand, through the skin, down the line of the triceps muscle, and another at right angles to it, along the line of the ulna: then carefully dissecting back the triangular flap of integument thus outlined, the parts to be examined come nicely into view.

13. In *Ampelis* the insertion of the *tensor patagii longus* and *brevis* are typically Passerine in character, as may be seen in the drawing here presented of these parts, which I made directly from my dissection (Pl. XVII. fig. 2), and from Prof. Garrod's excellent description, in his memoir upon the anatomy of the group†, of this method of insertion, as we find it in nearly all Passeres.

In *A. cedrorum*, however, we find another patagial muscle present in all Passeres which I have examined, which elsewhere I have named the *dermo-tensor patagii*, marking it *dt.p.* in

* Nitzsch's 'Pterylography:' translated from the German by W. S. Dallas, and edited by P. L. Sclater, for the Ray Society. London, 1867: Taf. iii. figs. 1 & 2.

† Garrod, A. H., "On some Anatomical Characters which bear upon the Major Divisions of the Passerine Birds," P. Z. S. 1876, pp. 506–519 (read June 6th, 1876).

Pl. XVII. fig. 2 of the present memoir. This muscle arises from the inner surface of the skin at the lower part of the neck, its fibres converging as they pass towards the shoulder to terminate in a small and delicate tendon, which accompanies the tendon of the *tensor patagii longus* in the free marginal fold of the patagium, and merges with it about halfway between the humerus and carpus. When I come to discuss this muscle in the *Hirundinidæ* I will enter more fully upon it, its relations, and the birds wherein I have thus far detected its presence.

14. The musculature of the lower larynx of *Ampelis cedrorum* is of a very perfect Acromyodian type; I distinctly make out *five* pairs of intrinsic muscles inserted, as usual in Passeres, into the ends of the three upper bronchial semi-rings; and, in addition to these, there is a well-developed pair of sterno-tracheales.

These lower laryngeal muscles are here not only firm and fleshy, but easily individualized—a feat best accomplished with a pair of dissecting-needles, under the 2-inch objective of a good microscope.

Both in structure and position, then, the syrinx of *Ampelis* is of a typical Passerine type.

15. Turning next to the *pectoral muscles*, I find all three—the *pectoralis major*, the *p. secundus*, and *p. tertius*—to be present and fully developed. They also have their usual origins and insertions.

16. In examining the muscles of the thigh, with their vessels and nerves, I find that the ambiens and accessory femoro-caudal are both absent, while the femoro-caudal, the semimembranosus, the semitendinosus, and accessory semitendinosus are all present. The main artery is the sciatic; the main nerve the sciatic nerve; and the main vein the femoral.

In all of these particulars *Ampelis cedrorum* agrees with the highest types of Passerine birds.

17. At the lower third and at the back of the tarso-metatarsus I find in both feet that the tendons of the *flexor longus hallucis* and the *flexor profundus digitorum* are not connected by a fibrous vinculum. This is also another Passerine character.

18. In examining the heart and great vessels, I find but one carotid artery—the left one—passing up in front of the vertebræ in the neck.

19. I find the nostrils in *Ampelis* but very feebly partitioned from each other by a median membro-cartilaginous septum.

20. The alimentary canal agrees in general with the Passerine birds, and a small pair of *cæca coli* are present.

The Skeleton of Ampelis.

To any one who has examined series of skeletons of Passerine birds, it is a well-known fact that, as we pass from one specific form to another, from the higher to the lower types of organization, or *vice versâ*, we are impressed with the very few and inconspicuous structural modifications that we encounter; as we serially investigate the allied species of a group or groups, the shading of nearly all of the morphological characters of one species into those of another, and of the latter into the next nearest related form, is, as a rule, extremely gradual, and almost beyond the power of the pen to adequately describe. Yet, if we choose birds from the extremes of the Passerine order, very excellent taxonomic characters are met with, and if closely studied often point to affinities otherwise obscure or very puzzling.

As shown in many of the characters of its skeleton, *Ampelis cedrorum* seems to hold a sort of middle position here; and I think we shall find that, in some particulars, it is not to be distinguished from the highest types of the Oscines, while in others it possesses marked affinities with the Clamatorial plan of skeletal structure.

21. *Of the Skull* (Pl. XVII. figs. 4 & 6).—We find the superior osseous mandible of *Ampelis* to be somewhat flattened or compressed from above downwards; the narial apertures are large and subelliptical in outline. This part of the skull is broad at its base, tapering rather gradually to its apex; while above, its naso-frontal regions gradually merge into each other, there being no well-defined transverse line dividing them. The median rhinal partition, or nasal septum, is wholly in cartilage in this bird (Pl. XVII. fig. 4)—a character wherein it agrees with such forms as *Hesperocichla* (Pl. XVII. fig. 5), *Merula*, and probably all the higher Thrushes, as well as with such a type as *Otocoris**. On the other hand, a very well-developed nasal septum is to be found in the skulls of the American *Tyrannidæ*, as, for example, in such a Flycatcher as *Tyrannus verticalis* (Pl. XVII. fig. 3). So

* Shufeldt, R. W., "Osteology of *Eremophila alpestris* [*Otocoris alpestris arenicola*]," Twelfth Annual Report U.S. Geol. and Geog. Surv. of the Territories, 1882, p. 652, pl. iv. fig. 22.

far as this character goes, then, *Ampelis* agrees, as it does in so many other particulars already defined above, with the Oscines rather than with the Clamatores.

We also notice that upon the underside of the superior osseous mandible in the Tyrant Flycatchers the greater portion of that space which occurs between the anterior limbs of the palatines is filled in by a continuous plate of bone, which joins them, while in *Ampelis* (Pl. XVII. fig. 6) this space is open, as we likewise find it in most (or perhaps all) Oscines. In the Tyrants the osseous nasal septum unites with this bony inter-palatine plate above and along its median longitudinal line.

There is but little to detain us upon the superior aspect of the skull; all the three specimens shown in Pl. XVII. figs. 3–5 are rather broad in this region, between the orbital margins, while a moderately well-marked median furrow is to be seen, which is best exemplified in the Thrush, and least so in the Tyrant Flycatcher. All the higher Thrushes have the facio-cranial line fairly well defined on this aspect. I have already remarked that it is barely traceable in *Ampelis*.

Upon the lateral view of the skull of this Chatterer (Pl. XVII. fig. 4) there are two or three points presented of more or less interest. The " pars plana," or antorbital plate, is found to be ample, and completely divides the orbit from the rhinal chamber. In front of this, on either side, is to be found a *freely* articulated little ossicle which I take to represent the *lacrymal*. It shows a constriction at its middle, giving rise to enlarged superior and inferior extremities. The superior end is wedged in between the antorbital plate and the postero-superior edge of the corresponding nasal. Below, its inferior dilatation rests upon the maxillary bar. Behind, it is applied against the anterior surface of the pars plana, while in front it is only in contact with the nasal superiorly, as already described. I find this bone present in *all* of the North-American *Tyrannidæ*, in the true *Corvidæ*, in the genus *Sturnella*, but absent in the *Icteridæ*, in the true Thrushes (*Merula*, *Hesperocichla*, Pl. XVII. fig. 5), in *Otocoris*, and others. I am not prepared, as yet, to say of what value it will eventually prove to be as a taxonomic character; but in the present instance it is just as well to note that this free lacrymal bone is found in *Ampelis* and the Clamatores (*Tyrannidæ*), and not in the true Thrushes.

The interorbital septum, in the specimen of *Ampelis* before me, is entire, although encroached upon above and behind by the great deficiency or vacuity in that part of the brain-case from which the first pair of nerves make their exit. The foramen for the exit of the second pair is no larger here than the size of the nerve demands. In *Hesperocichla* both of these foramina are considerably larger than is required for the passage of the nerves, while in addition a vacuity occurs in the interorbital septum of the Thrush.

Among the higher types of Thrushes, as in the one just referred to, the bony entrance to the ear looks *directly forwards*, while in the *Tyrannidæ* this aperture looks downwards, forwards, and outwards; in the case of *Ampelis* it is more as we find it in *Hesperocichla*, and in both of these latter forms a conspicuous shell-like covering of bone is developed from behind forwards, which protects this important orifice.

In all the true Passerine birds that I have examined a *quadrate* bone has a well-pronounced orbital process; two facets upon its mandibular foot, the outer being placed transversely, the inner obliquely; while the long diameter of its mastoidal head is also transverse, and supports two articular facets in *Ampelis* and the Oscines, which facets in the *Tyrannidæ* almost completely merge into one.

Turning now to the under view of the skull as shown in Pl. XVII. fig. 6, we observe that the anterior extremities of the palatines (*pl.*) are very slender and wide apart. I have already pointed out how the space between them beneath the superior osseous mandible is filled in by a plate of bone in the *Tyrannidæ*. The postero-external angles of the palatines in *Ampelis* are rounded and projecting, much as we find them in some Swallows, and not very unlike the form they assume in some Swifts.

In this Chatterer the hinder portions of the palatines are considerably extended laterally, and lie principally in the horizontal plane; whereas in such a bird as *Hesperocichla* they are less noticeable for this, while on the other hand their internal and external "*laminæ*" are better developed in this Thrush.

So far as I have examined, in all Passerine birds these bones meet for nearly the entire length down the middle line to the articulation of the pterygoidal heads, and only diverge slightly in front to meet the backward-extending forks of the vomer.

The *maxillo-palatines* (Pl. XVII. fig. 6, *mxp.*) are markedly long and slender in *Ampelis*, and mesially separated by an unusual interval. They slightly exaggerate, however, the conditions in which we commonly find them among the Passeres generally. This remark applies also to the *vomer* (*v.*), which, too, is rather broad, though it bears out its Passerine character in being anteriorly truncate with somewhat produced lateral tips at that extremity to meet the cartilaginous wings of the nasal septum.

Among the *Tyrannidæ*, the palatine heads of the *pterygoids* meet each other beneath the rostrum of the sphenoid; these parts are separated by quite an interval in *Ampelis* (Pl. XVII. fig. 6, *pt.*), as they are also, though to a less extent, in the Thrushes (e. g., *H. nævia*). Here, again, the Chatterer agrees with the typical Oscinine bird. In general form the pterygoids of *Ampelis* agree with those bones as we find them in other Passeres.

In view of the fact that the general characters of the skull of a Passerine bird are well known, and as I believe that I have now thoroughly directed attention to the most important departures therefrom, or similarities therewith, in the foregoing paragraphs, there is nothing else that remains worthy of special record in this skull of *Ampelis*, and the notes thus far made will meet all requirements of reference for what has to follow.

The *mandible* of *Ampelis* is but feebly developed when compared with that bone as we find it in others of this great group of birds. It has more the appearance of a Swallow's jaw than that of either a Thrush or a typical Flycatcher. In general form, however, it is essentially passerine, having an outline not very unlike the mandible of *Otocoris alpestris* (fig. 29 of my memoir upon the Osteology of that Lark). A minute ramal vacuity is present, which is found to be larger in the *Tyrannidæ*, and of a still greater size in *Hesperocichla*. As might be expected, the mandible in the Flycatchers is a much stronger and comparatively heavier bone than it is in these Oscinine types.

22. The *hyoid arches* in our subject are likewise typically Passerine in character, having their several elements delicately constructed, with first and second basibranchial in one piece; with a cartilaginous glosso-hyal, and with comparatively large and free cerato-hyals. *Lanius* is a bird that shows very well the

Passerine pattern for the hyoid arches, and I have elsewhere figured them for that form *.

The *sclerotal plates* of the eye are composed of separate little pieces of bone in all of these birds of which we have been speaking; but in old specimens in some of the *Tyrannidæ* I have often noticed their tendency to anchylose together, notably in the genus *Sayornis*.

Passeres usually have a small sesamoid bone at the angle of the jaw. I have failed to find it in *Ampelis*, but would prefer examining more specimens before positively announcing its absence. It seems to be invariably present where indicated in all of the higher Thrushes.

23. *Of the remainder of the Axial Skeleton.*—It will be probably a very long time before a sufficient number of the vertebral columns of existing birds have been examined, to ascertain with certainty whether the vertebræ composing them are constant for the several divisions and for the species. When this has been done, and the exact averages ascertained, the result will be no doubt important in assisting to decide doubtful points in classification

The figures recorded in the subjoined Table have in every case only been set down after carefully counting the segments two or three times. With respect to the number of vertebræ in the consolidated sacrum of the pelvis, they are here counted in the adult bird, and consequently must be taken *cum grano salis*, though I believe them to be quite correct.

I am inclined to think at present that the number of free coccygeal vertebræ are liable to vary even in representatives of the same species.

This Table, of course, could easily have been made far more extensive, but in that case would have overstepped the object at present in view. I trust, however, that those who at any time may be engaged in examining the structure of birds will record such data as I have attempted to do here, and only after the most careful counting. To do this, reliance can be placed only upon spirit specimens, or recently killed birds, where there has been no possibility of any of the vertebræ having been lost.

* Shufeldt, R. W., "Osteology of *Lanius ludovicianus excubitorides*," Bull. U.S. Geol. and Geog. Surv. of the Territories, vol. vi. pp. 351–359, pl. xiv. fig. 101. Also same plate and figure in the author's collected memoirs 'Contributions to the Anatomy of Birds.'

Species.	No. of vertebræ before reaching the sacrum.	First free pair of ribs occur on the	No. of vertebræ in sacrum of pelvis.	No. of vertebræ in coccygeal division, including pygostyle.
Ampelis cedrorum	18	12th.	10	9
Hesperoeichla nævia......	18	12th.	12	7
Tyrannus verticalis	19	13th.	10	8
Otoeoris alpestris	18	13th.	11	7

Of this kind of data I think the greatest reliance is to be placed in the number of *free* vertebræ in the cervical + the dorsal region, as shown in the first column, far more than that shown in the three remaining columns. If we take immature birds, however, chosen just at that point in their development when we can count with certainty *exactly* how many of these segments will enter into the pelvic sacrum, and *exactly* how many will be appropriated by the pygostyle, then the total count of *all* the vertebræ in the column, irrespective of its divisions, will be of value.

24. In both *Ampelis* and *Hesperocichla five* pairs of dorsal ribs possess costal ribs that meet the sternum, and each of these birds have a pair of ribs that spring from the first sacral vertebra, which articulate below with a pair of "floating" costal ribs. This condition also obtains in my specimen of *Tyrannus verticalis*, but in this species there are only *four* pairs of costal ribs that articulate with the sternum. These "sacral ribs" are without epipleural appendages, though these processes are found freely articulated at their usual sites upon all of the true vertebral ribs in the several birds just alluded to.

25. It has been always a matter of some surprise to me that the *pelvis* of a bird has not had that importance attached to it among skeletal characters which has been so universally awarded to the sternum. In many respects its form in some species is far more distinctive of the bird to which it belongs than the sternum can be, and is consequently more reliable. For instance, the sternum of Passerine birds varies but very little throughout the group, and in many cases it would be very difficult to designate the species by simply examining the sternum alone; moreover the

sternum may sometimes assume a different form even for the same species*, which I have never found to be the case in the pelvis.

In Pl. XVIII. fig. 7 is represented the superior or dorsal view (double the size of life) of the pelvis of *Ampelis cedrorum*; it shows very well indeed the general form and characters of this bone as it occurs among the Passeres. Considerable interest attaches, however, to an examination of a transition series of pelves through the Passerine group of birds into other orders wherein marked differences are to be found.

Now in such a bird as *Harporhynchus rufus*, for instance, or any of its genus, the pelvis, when viewed from above, has pretty much the same form as it has in *Ampelis*; but all the processes are more prominent, and all the ridges and crests more conspicuous and defined. This lends to the bone quite a striking appearance in these higher Thrushes. But as we pass through the members of the Oscinine group and into the Clamatores, this bone, although it retains its general pattern, gradually loses this peculiar angularity, and gains in breadth while it becomes comparatively shorter in the longitudinal direction. My meaning will be made clearer when we come to examine, further on, *the pelves of the Swallows and Swifts.*

As to the characters of the pelvis in *Ampelis*, we are to note that, anteriorly on its dorsal side, the inner margins of the ilia are widely separated from the crista of the sacrum; that the pre- and post-acetabular areas are about of equal dimensions, that the former are concave outwards, while the reverse condition obtains with the latter; that the "sacrum" upon this view is roughly lozenge-shaped, and that interapophysial foramina of varying sizes may be found to exist in it.

Upon the lateral aspect it is to be observed, that not only is the acetabulum (as it invariably is in birds, I believe) completely surrounded by bone, but the ischiadic, the obturator, and the obturator space are true foramina, or at least are entirely encircled by bone. In *Tyrannus verticalis* the ischium fails to meet the post-pubis between the obturator foramen and obturator

* For examples of this see my remarks upon the different forms of sternum in the Cathartidæ, "Osteology of the Cathartidæ," in Contributions to the Anat. of Birds, from U.S. Geol. and Geog. Survey, 1882 (Hayden's 12th Annual), pp. 771, 772, where four figs. of sternum of *C. aura* are given.

space, and thus convert these openings into veritable vacuities, as is the case in all of the Oscines that I have alluded to elsewhere.

Otocoris agrees in this respect with the Oscines, as may be seen in my side-view figure of its pelvis (Contrib. Anat. Birds, pl. iv. fig. 22).

The post-pubis in *Ampelis* extends but slightly beyond the hinder extremity of the ischium, which latter meets it behind in a broad foot-like process. These parts in the dried skeleton are very apt to curl outwards, and deceive us as to the true shape of this part of the pelvis during life; so that it is only in fresh specimens that we can gain a correct notion of this bone in most Passeres.

This post-preparatory deformity of this part of the skeleton has been taken into consideration in figure 7, and duly corrected.

The coccygeal vertebræ and pygostyle in *Ampelis* require no special description, for they agree in all essential particulars with the parts as found among the Oscines generally. They are very well shown in my figure of the skeleton of *Otocoris*, alluded to above.

In *Tyrannus* the coccygeal vertebræ are comparatively very large and their diapophyses very broad.

26. As we would naturally be led to suspect, the *sternum* of *Ampelis* is, of course, a thoroughly Passerine one, having the characteristic bifurcation of the manubrium; the lofty costal processes, the well-developed and deep carina, the cordate-shaped notch on either side of the xiphoidal extremity, and the *five* facets upon either of its costal borders.

Among the American *Tyrannidæ* the sternum has essentially the same shape, but it has only *four* facets for the hæmapophyses upon each of its costal borders.

A fuller description of this bone will not be required here. I have already published a pectoral view of a typical Passerine sternum elsewhere (Coues's 'Key,' 2nd ed. fig. 58), and other forms of it may be seen in my figures of the sterna of *Lanius*, *Otocoris*, and others, in memoirs already cited.

This bone will be taken into consideration again, further on, when we come to treat of the sterna of the Swallows, Swifts, and Humming-birds.

27. The elements of the *shoulder-girdle* in *Ampelis* more closely resemble those parts in the typical Oscines than in the Clamatores. In form and arrangement they make scarcely

any perceptible departures from such structures as we find them in *Lanius* (see Contrib. Anat. Birds, pl. xiv. figs. 93, 94, 95, and 100).

The blade of a *scapula* is sabre-shaped, long and narrow, and anteriorly abuts against the laterally compressed and expanded end of the furcula of the corresponding side. The shaft of a *coracoid* is long, slender, and subcylindrical in form. Its clavicular head is tuberous, being hooked forwards and inwards.

The *furcula* typifies the U-shaped pattern of this bone, and I would especially call attention here to the form of its hypocleidium in *Ampelis*. This process is a long, *suboval*, laterally compressed lamina of bone, directed upwards and backwards towards the manubrium, when the girdle is articulated *in situ*. My figures, already referred to above, of *Lanius* and *Otocoris* show very well this form of the hypocleidium of the furcula.

Now in *Tyrannus verticalis*, taken as representing the Clamatorial group of birds, this process of the furcula is nearly circular in outline, and *decidedly smaller*. Little points of this kind, when they are found to be constant, should be borne in mind here, for they will surely arise again, when we come to see how such characters are exhibited among the Macrochires.

28. *Of the Appendicular Skeleton.*—Not only in the case of *Ampelis*, but with the Passerine birds generally, the composition, forms, and structure of the skeleton of the limbs are so well known, that I will not here attempt to add anything to this part of my subject. So far as the bones are concerned, I fail to find, even upon close scrutiny, any reliable set of characters that one could use with certainty in deciding in any case whether the *skeleton* of a leg or a wing belonged to an Oscinine or a Clamatorial bird.

When we come to deal further on with the skeletal limbs of the Macrochires and others, where such characters as are present in these parts in the Passeres can be, if ever, usefully compared, it will then be ample time to bring them forward for comparison, and decide whether these structures afford anything helpful in determining affinities. To recapitulate here the well-known points in the skeleton of the limbs in a Passerine bird would, I am sure, avail us nothing.

Suffice it to observe that in its organization *Ampelis* is by the majority of its structural characters an Oscinine bird, though it also presents here and there in its economy traces of a Clamatorial type, such as is shown in its free lacrymal bone and a few other minor points. I fail to find anything in its morphology that especially connects it with the *Hirundinidæ*. As I anticipated, however, the brief synopsis of its structural characters goes to show, in support of the views already elsewhere expressed by Garrod, that *Ampelis* has an organization of an average Oscinine bird, by which I mean not typically so, and consequently will be of service here as an aid to comparison as we proceed.

Osteology of Trogon mexicanus and Trogon puella.

As will be seen by my tabulated list of material, I am indebted to Dr. Sclater for two excellent skeletons of these Trogons. He kindly had them prepared for me, and sent by post in ample time to use in the preparation of the present memoir.

In my first paper upon the Macrochires, I stated that I wished to compare the skeleton of a Trogon with one of a Humming-bird (P. Z. S. 1885), as Forbes had found in them a peculiar structure of the palate, which led me to believe that there might be other points in the skeleton of one of these birds which would indicate some remote affinity perhaps with the Trochili. Hence it was with no little interest that I opened the package that Dr. Sclater had sent; but my eyes had no sooner fallen upon the two neatly prepared specimens it contained, than the exclamation was forced from me, "Why, they are Caprimulgine Cuckoos!"

How well this first impression will be supported by a careful examination of the skeleton in detail we will now see.

In figuring the osteology of the Trogons, based upon these two specimens, I chose the skeleton of *T. mexicanus* for all my drawings. This I did as it no doubt agrees in all particulars with the skeleton of our own Trogon, *T. ambiguus*, and I have long been desirous of contributing to the knowledge of the osteology of that lone species of the genus in the United States avifauna.

Practically, however, a description of the skeleton of *Trogon mexicanus* will answer very well for the skeleton of *T. puella*, for there is but very little difference between them. I must not, however, be understood to say that the difference in the skeletons of these two species is of so slight a nature that we cannot readily distinguish them; for if a series of each were mixed up before me, there would be no difficulty whatever in rapidly selecting the skeletons which belong to either of these two species. As I proceed with my detailed descriptions, I will point out the more marked of these differences, while my observations must be considered as applying directly to the skeleton of *T. mexicanus*, unless otherwise specified.

Of the Skull (Pl. XVIII. fig. 8, and Pl. XIX.).—Viewing this part of the skeleton from above, we find that a strong transverse line separates the superior osseous mandible from the fronto-lacrymal region, which latter arches upwards and backwards from it. This superior mandibular portion of the bony beak is rather low from above downwards, broad at the base, tapering rapidly to the tip, while its osseous tomia are sharp, and the culmen is a graceful, rounded, and unbroken arch from the frontal region to the tip of the beak. The narial apertures at its sides face upwards and outwards; they are large, of an elliptical outline, and with smooth, rounded edges.

Each *lacrymal* bone is a somewhat slender, peculiarly-shaped element of an *f*-like form, which freely articulates by its superomesial surface or moiety with a vertical facet offered by the corresponding frontal. Its upper end rises above the surrounding surface of the skull, while its lower extremity fails to reach the quadrato-jugal bar below.

The region between the orbital peripheries on the superior aspect of this skull is very narrow, and presents a shallow longitudinal furrow. Posterior to this part the parietal region is characterized by two laterally placed roundly convexed eminences, with a rather better marked median longitudinal track between them, being the continuation of the furrow just alluded to in the interorbital region.

Viewing the skull of this Trogon upon its lateral aspect, this marked rounding of the parietal region lends to it rather an unusual configuration for the cranium among birds.

Upon this view, too, we must note the rudimentary condition of the sphenotic process, while the squamosal apophysis below it is large and conspicuous. The interorbital septum, *per se*, is entire though very thin, while, on the other hand, the foramina at the posterior aspect of the orbital cavity are far larger than is required for the nerves to which they severally give passage; especially is this true of the superior vacuity. In both of these Trogons, however, although these foramina are very large, they still retain their individuality, and do not merge with each other.

At the upper part of the interorbital septum we observe, plainly marked, the track for the first pair of nerves. It does not in either of these specimens communicate, through a thinning of the walls, with a similar track in the opposite orbital cavity, as we often see in other birds.

Anteriorly the partition between the orbit and rhinal chamber is composed of an exceedingly small *pars plana*, and of a thin membrane which stretches from it to the already-described lacrymal bone. In the dried skeleton, after the membrane has been removed, the communication between these two cavities is unusually free, more so than in any other bird that I happen to recall at the moment. The periphery of the orbit is sharp for its anterior two thirds, but becomes rounded off as it passes backwards over the anterior wall of the brain-case in line with the lateral processes of the skull.

Sutural traces among the original elements composing the quadrato-jugal bar are hardly perceptible, and this osseous rod is quite straight from one end to the other, its tip only being bent up as it articulates with the quadrate.

Each *nasal* bone, in this skull, has completely merged with the premaxillary and frontal of the same side, so that all traces of its original borders are obliterated, and it has become thoroughly incorporated in the conformation of the osseous superior mandible.

We will now turn to the underside of the skull of *Trogon mexicanus*, where we find many points of interest presented for examination. Approximately speaking, the majority of structures observable upon this aspect are found in the same horizontal plane, which plane nearly includes the entire foramen magnum, and the anterior moiety of this opening may be said to lie in it.

The roof of the anterior half of the mouth is composed of a continuous plate of bone contributed by that portion of the premaxillaries. Into the hinder border of this plate we find the anterior and dilated ends of the palatines merging. At this point these latter bones are quite close together; posterior to it, however, an oval, longitudinal interpalatine space occurs through which we can see the osseous nasal septum and the vomer.

These latter structures will be alluded to again after completing the description of a palatine bone.

The anterior half of a palatine is a narrow ribbon of bone placed horizontally, dilated at its further extremity, which, as has already been said, blends with the horizontal portion of the corresponding premaxillary. The posterior division of the bone feebly develops an inner and an outer carination, the "postero-external" angle being completely rounded off.

In the median line, beneath the basisphenoidal rostrum, these palatine bones meet each other, and in front the vomer, for their entire lengths, a union which, in both *T. mexicanus* and *T. puella*, seems to amount to an absolute anchylosis.

If this prove to be universally the case in the skulls of fully adult Trogons, it need not surprise us, for when we come to the Humming-birds there will be another peculiar anchylosis to be described that is occasionally to be found in their skulls.

Now the *vomer* (fig. 8, *v.*) in both of these Trogons is a rather short subcylindrical rod with a bluntish point. This point rests directly upon the posterior free edge of the osseous nasal septum (*n.s.*).

This intimate relationship between the vomer and nasal septum in the Trogons led the late W. A. Forbes into an error, which will be at once evident upon an examination of his drawing of these parts in *Pharomacrus mocinno* (P. Z. S. 1881, p. 837). At least it does not hold quite true in the species at hand; and I suspect that Forbes, in examining alcoholic specimens, included this thin posterior edge of the nasal septum with the anterior tip of the vomer, giving it that "thin and filiform" appearance to which he alludes. This slight error might easily be made by that kind of an examination, when in a dried skull, such as I have before me, these parts would be better distinguished. His description, however, in the contribution above referred to, is a marked improvement upon that by Professor Huxley, which it was written to correct; and the former writer was fully aware of the fact that the nasal septum in the Trogons ossified. In my specimen of *T. mexicanus* this plate has a large vacuity in its centre, while in *T. puella* it is entire.

The tips of the *maxillo-palatines* do not show in the interpalatine median space, upon this view of the skull, as they are said to do in *P. mocinno* by Forbes in the paper just quoted. (Compare figure in P. Z. S. 1881, p. 837, and fig. 8 of the present paper.) Indeed, I can fully verify Forbes's statement that the Trogons are not desmognathous birds, but very decidedly schizognathous; and, furthermore, I am inclined to believe that there is a fair measure of truth in the words of this anatomist when he stated "that the structure of the palate has not that unique and peculiar significance that has been claimed for it in the classification of birds." My eyes were opened to this fact more thoroughly than ever when I came to find such a bird as *Chordeiles* completely desmognathous, while certain forms of *Caprimulgus* and *Phalænoptilus* were ægithognathous, as defined by Professor Huxley in his well-known "Contribution to the Classification of Birds" (P. Z. S. 1867, p. 468).

Large *basipterygoid processes* are developed both in *T. mexicanus* and *T. puella*, which in each case are articulated with ample facets upon the pterygoids themselves.

The palatine heads of the *pterygoids* are widely separated in the median line; while, as I have already stated, the palatines opposite their place of meeting them are in contact to their very ends. The outer edge of a pterygoid is quite sharp, while this bone is compressed from above downwards and articulates in the most usual manner by a ball-and-socket joint with the corresponding quadrate.

A *quadrate* develops a long orbital process with dilated tip. Its mandibular foot supports two facets upon it, which are separated from each other by an intervening valley. There are also two such facets upon the squamosal head of the quadrate. Otherwise this element is notable for the unusually long apophysis it offers laterally to meet and articulate with the posterior end of the quadrato-jugal bar.

The underside of the basisphenoidal rostrum is much thickened and rounded for its entire length, thus affording a broad sliding surface for the articulation of the pterygo-palatine ends. Barely an apology for a bony scale overhangs the entrances to the Eustachian tubes, while immediately behind them the base of the cranium is very broad between the aural apertures. The occipital condyle is comparatively very small indeed, though the subcircular foramen magnum is fully up to the average in point of size. Upon either side of it, we find the usual group of foramina for the passage of nerves and vessels (Pl. XVIII. fig. 8).

I have made no special examination of the interior of the cranial casket in these birds, but we are to note the great delicacy of the walls of this part of the cranium and how thin they are. Air seems to gain access to the major portion of the skull in both of these specimens, including the quadrates and perhaps the pterygoids.

I am reminded in my examination of the *mandible* of *Trogon* of the form this bone assumes in some of the smaller American Owls, as *Speotyto* for example. Its articular ends are rather large, being bluntly pointed behind, and having long, sharp, in-turned mesial tips.

The borders of the rami are rounded off, while their height remains quite uniform for the entire length of the jaw. Upon their outer aspects, for the posterior moiety of each, an excavation occurs, at the middle of which, on either limb, is seen a small ramal vacuity.

The symphysis is deeper by half again than either ramus, and the superior border above it is sharpened. In general outline the mandible of a Trogon is broadly V-shaped, and this bone is partially pneumatic.

So far as these two specimens are concerned, I find that *T. puella* differs from *T. mexicanus* in its skull in having an entire osseous nasal septum, a rather wider frontal space on the superior aspect of the skull between the orbital margins, the parietal eminences are not so lofty, and a better developed osseous lip protects the entrance to the Eustachian tubes. Their mandibles are essentially similar.

Of the Hyoid Arches.—As might be expected, these practically present little or no difference in the two species of Trogons before me. The hyoid arches in *T. mexicanus* are small as compared with the size of the skull of the bird, the thyrohyals barely curving up behind at all. The apparatus as a whole reminds me not a little of the hyoid arches in some of the smaller American Owls (*Glaucidium*).

The glossohyal is formed entirely of cartilage, while the ceratohyals have ossified. In this adult bird the first and second basibranchials are joined in one piece by anchylosis, the cerato-branchial of the thyrohyals apparently articulating in the lateral sockets at their point of union.

Cartilaginous tips finish off the hinder ends of the epibranchials, and these elements of the "greater cornua" are nearly straight longitudinally, nor are they notably curved in the direction of the median plane of the body.

Of the Remainder of the Axial Skeleton.—From a careful examination of the vertebral column of both of these Trogons, I am enabled to present the subjoined table of data in regard to this part of their skeletons and in which both these species agree :—

Number of cervical vertebræ without ribs	12
The first cervical vertebra supporting a pair of free ribs	=13th.
The first vertebra of the column wherein the ribs articulate with the sternum by means of costal ribs is the	14th.
Number of true ribs thus articulated	4
Number of hæmapophysial facets on sternum........	4
Number of true dorsal vertebræ	5
Number of vertebræ consolidated with pelvis........	12
Number of caudal vertebræ (free) including the pygostyle are	7

It will be noted from this table, of course, that the pair of vertebral ribs attached to that vertebra here called the fifth dorsal have costal ribs that do not meet the sternum, but articulate with the hinder borders of the last pair of costal ribs that do.

There is also a pair of ribs that spring from beneath the fore part of the sacrum, articulating with the first or anterior vertebra, that becomes consolidated with the pelvis. These ribs also meet short and free hæmapophyses below, which in their turn articulate with the posterior margins of the pair of first or leading "floating ribs" referred to in the foregoing paragraph.

Neither the last pair of dorsal vertebral ribs nor the sacral vertebral ribs possess epipleural appendages ; consequently we have but five pairs of true vertebral ribs that do support these processes.

And, further, we ascertain from the table that the total number of free vertebræ in the column before we arrive at the first one that becomes consolidated with the pelvis is 18.

Among the principal characteristics of the first twelve vertebræ of the column we are to note that the usual outstanding processes, such as the neural spines, parapophyses, and hyapophyses, are but feebly developed, being for the most part short and inconspicuous. The superior spines of these vertebræ are most prominent in the axis and next following three or four segments.

In neither of the specimens examined does a perforation exist in the cup of the atlas, while the neural arch of this vertebra is comparatively narrow.

The hypapophysial processes of the fifth, sixth, seventh, and eighth cervical vertebræ part mesially in order to form a canal for the protection of the left carotid artery, the only one present in these birds (Garrod), as it passes to the head.

Upon the last few cervicals, and upon the first two or three dorsals, very well-developed hypapophyses are to be found, which may become tricornuted towards the latter end of the segments specified (*T. puella*).

Diapophyses of the dorsal vertebræ are notoriously broad, with their outer extremities rounded, being considerably wider even here than the bodies of the ribs that articulate beneath them (*T. mexicanus*).

Below, the centra of these dorsal vertebræ are deep and much compressed laterally; their median, longitudinal, inferior lines being almost cultrate in character.

The dorsal neural spines are all nearly of the same height, but, on the whole, rather low in point of altitude. Their superior rims are thickened, and interlock at their anterior and posterior ends. These five dorsal vertebræ, although freely articulated, are very closely moulded upon each other, and consequently the mobility of this division of the column is somewhat limited.

Facets for the vertebral ribs are here, as usual, found for each pair just within and posterior to the anterior margins of the centra of the respective vertebræ at their lateral aspects.

Thus far in the column of these Trogons the plan of articulation seems to be truly "heterocœlous," *i. e.* the ends of the centra present saddle-shaped facets, which in turn lock with a counter-placed one on the opposed face of the vertebra next behind.

Of the Sternum.—Leaving the vertebral column for the moment, we will turn our attention to this bone. There is a good deal in the sternum of *Trogon* to remind us of the same part of the skeleton in *Geococcyx*; of which we may at once satisfy ourselves by comparing the figures of the bone as it is found in these two forms and shown in my plates. Figures of the sternum of *Trogon mexicanus* illustrate this memoir (Pl. XIX. figs. 12, 13), while corresponding views of it for *Geococcyx* are to be found in the plates of my contribution upon the osteology of *G. californianus* in the 'Journal of Anatomy and Physiology' for 1886.

Among the Trogons the sternum is short, and, when taken in comparison with the size of these birds, rather expansive behind, where it shows two deep rounded notches on either side of the carina. The outer pair of lateral processes which are thus produced have expanded posterior ends. As already stated, each costal border supports four small transverse facets for the hæmapophysial ribs, which are crowded pretty close together. Beyond these the costal processes are of a quadrate outline on either side, and are directed upwards and very slightly forwards as conspicuous projections.

Trihedral in form and rather inclined to bifurcate at its summit, the well-developed manubrium is cultrate mesially in front and this prominent apophysis rears itself upwards and forwards from its usual site, as seen in birds generally where it is present. Immediately behind it are the coracoidal grooves, which, though narrow from above downwards, extend far out laterally and meet, or very nearly meet, at the middle point posterior to the manubrial base.

The keel of this bone is comparatively deep and extends the entire length of the sternal body, while its inferior border is gently convex for its entire length forwards, and its anterior one considerably concave. At their intersection in front the carinal angle is bluntly rounded off.

From the fact that the xiphoidal processes are spreading in character and the sides of the sternal body uniformly raised, not an inconsiderable concavity is enclosed on the thoracic aspect of this sternum; and, as is usually the case in birds of this form, the pelvis above is seen to be correspondingly widespread, indicating roomy abdominal and thoracic cavities within their enclosure.

Pneumaticity is not a prominent feature of the sternum among the Trogons, although a few insignificant foramina do admit air to this bone where such openings ordinarily occur.

Of the Shoulder-Girdle (Pl. XIX. fig. 13).—We find the *os furcula* to be of the U-shaped variety, with a well-formed hypocleidium of a rounded outline at its clavicular junction beneath. The limbs of this bone are slender, while the heads are somewhat expanded and much compressed laterally. They rest against the mesial aspects of the superior tuberosities of the coracoids, and on either side extend backwards to the scapula, which they overlap to some extent, resting upon the upper side of the clavicular process of the bone.

A *scapula* here makes the usual articulation with a coracoid and offers the proportional amount of articulatory surface to the glenoid cavity. Its blade is narrow, rather long, of an equal width throughout, and compressed from above downwards. Posteriorly its extremity is obliquely truncate from within outwards, while the end itself is slightly curved in the same direction.

Either *coracoid* is characterized by a very extensively expanded sternal extremity of a quadrilateral outline, and of no great thickness in the antero-posterior direction. The shaft of the bone above this dilated end is rather slender, subcylindrical, being compressed from before backwards, and is evidently hollow. Its summit is not conspicuously enlarged, though it is rather more tuberous than we find it in such a group, for instance, as the Passeres. The head is directed in the articulated skeleton upwards, forwards, and inwards. Its scapular process is not very wide, for the scapula projects over it a little, both mesially and to its outer side; while in the former direction it stands between its superior articulating edge and the corresponding head of the clavicle, *i. e.* the scapula does. Air seems to gain access to the shafts of the coracoids, and perhaps to some extent to the extremities of these bones; but, so far as I have been able to discover, neither the *os furcula* nor the scapulæ possess any pneumaticity.

Neither of these Trogons possess, upon either side, the little ossicle at the shoulder-joint known as the *os humero-scapulare*, though it is just possible that it may in every case have been removed by accident during the preparation of the specimens.

Of the Pelvis and the Coccygeal Vertebræ.—No marked differences distinguish the pelves of these two species of Trogons. There is some general resemblance between the pelvis of *T. mexicanus* and the bone as we find it in certain Caprimulgine birds, though when we come to the details in such a comparison the divergence is sufficiently marked.

Viewing the pelvis of *Trogon mexicanus* from above, we observe that the preacetabular area is considerably more extensive than is the postacetabular (Pl. XIX. fig. 14). The outline of this upper surface is somewhat quadrilateral, its average width being about equal to its average length. In this specimen there are no existing vacuities among the diapophyses of the sacral vertebræ. One or two extremely minute ones are found in these positions in the specimen of *T. puella* among the ultimate vertebræ.

Marked lateral extension characterizes the transverse processes of the sacral vertebræ, more especially those three which are about opposite the acetabulæ; those in front and behind these are proportionately graduated off; and although, as I have observed, no foramina exist among them, the overspanning bone is in some places exceedingly thin.

The anterior margins of the ilia are obliquely truncate from a direction within outwards and backwards; and these borders have a delicately thickened rim. Internally, the margins of these bones fail, on either side, to meet the consolidated neural crest of the leading sacral vertebræ, there being short "ilio-neural canals" present in the pelves of these Trogons, of some two millimetres in width.

As to the superficial form of the several areas of this pelvic roof, we find the anterior moieties of the ilia to be concave; the posterior and smaller ones convex; and the middle area, formed by the sacrum, is an ample lozenge in its general outline.

Turning now to the lateral aspect of the pelvis of this Trogon (Pl. XIX. fig. 13), we are to observe that the anterior or pre-acetabular division of the bone lies in the same general plane with the longitudinal axis of the dorsal vertebræ, while there is a gradually increasing droop of all the hinder division of the bone, until we arrive at the slender post-pubic element, the posterior extremity of which turns slightly inwards and upwards.

Comparatively speaking, the acetabulum is rather small, and its base is deficient in bone, being so rendered by the usual circular vacuity there. The antitrochanter occupies here its common site, above the acetabulum, and faces forwards, downwards, and a little outwards. Behind it again we find an ample and subelliptical ischiadic foramen, situated thoroughly within the borders of the surrounding bone. The obturator space and the obturator foramen have so merged with each other that scarcely a distinguishing trace of separation can be detected between them.

A long subelliptical foramen is thus formed, the lower margin of which is bounded, as usual, by the narrow bar of the post-pubic element, as it sweeps by to the rear. This foramen is closed in behind by the foot-like process of the ischium which descends to meet the post-pubis, the latter extending for some three or four millimetres behind it, and thereafter taking a direction already described in a foregoing paragraph.

On the underside of this pelvis we find its "basin" to be wide and capacious, though not at any point correspondingly deep. The first three or four sacral vertebræ throw out their lateral processes to abut against the nether surface of the ilia, on either side, their extremities co-ossifying with the same; while the leading vertebra of all of the sacrum, as I have already said above, supports a pair of freely articulating ribs. A strong pair of lateral processes come off from the sacrum opposite the acetabulæ, and by abutting against the inner pelvic walls just above these circular apertures, they form strong braces to this part of the pelvis. Other members of the class frequently possess this feature. Now the posterior border on either side of this pelvis shows scarcely any mark to distinguish the union of the ilium and ischium, beyond a slight elevation at the usual point; in some birds, as we are aware, a notch defines the place.

Among the coccygeal vertebræ of the tail the transverse processes are all long and spreading, the last three being conspicuously so. Their neural spines are low and not prominent; while only the ultimate vertebra supports a bifid hypapophysis beneath its centrum.

To complete my account of the axial skeleton of a Trogon, it may be noted that the *pygostyle* is of a rhomboidal outline, with a considerably thickened base, and a perforation in its plate-like part near the supero-anterior angle.

Of the Appendicular skeleton; the Pectoral Limb (Pl. XIX. figs. 12–14).—No very striking feature distinguishes the *humerus* of one of these birds from the same bone as we find it in a considerable number of the Passeres. It seems to be thoroughly pneumatic, and the fossa that harbours the foramina occupies its usual site, and is surrounded in the usual manner by the ulnar crest at the proximal extremity of the bone.

The radial crest is rather low; its free border being long and convex, and the plate itself being bent palmad, as we so commonly find it among Passerine birds.

Coming to the shaft, we find it to be of a subcylindrical form, somewhat compressed laterally, and possessing the usual sigmoid curve, only in a moderate degree.

Nothing worthy of special record marks the distal extremity of this humerus, it being tuberous only to an extent in harmony with the general size of the bone; and upon its palmar aspect are to be found the two usual tuberosities for articulation with the bones of the antibrachium.

In neither of the Trogon skeletons at hand do I find any sesamoid bones present at the elbow-joint; but it is just possible that these birds may possess them, and that in the present instance they have been lost in the preparation of the skeleton; I am inclined to believe, however, from the general appearance of the dried ligaments and other structures that have been retained in one specimen, that the Trogons do not have these ossicles at the elbow-joint.

Turning to the bones of the forearm, we observe that the shaft of the *radius* is very slender and nearly straight. Its extremities are comparatively but slightly expanded, and on the whole this bone is not so powerfully developed as we find it in many birds of the same size. The interosseous space between it and the ulna is ample, but is largely due to the curvature in the shaft of the latter bone. The *ulna* has the usual form as we find it in some of the Passeres. Its olecranon process, however, is not conspicuous, while the shaft is smooth, subcylindrical, and devoid of the row of papillæ for the insertion of the quill-butts of the secondaries of the wing, so prominent in some birds, as, for instance, many of the *Picidæ*.

Radial and ulnar ossicles compose the carpal joint, and make the usual articulations with the surrounding bones. I am unable to discover any sesamoids about this joint, and am of opinion that none exist.

Extending our observations to the hand, we may note the peculiar form of its main bone, the carpo-metacarpal. This peculiarity does not consist in any radical change of its form as it is found to be in most birds, but of the unusual width it assumes at its distal end, in the antero-posterior direction (Pl. XIX. fig. 13). The increase of surface thus gained is for the accommodation of the articular facet for the single and terminal phalanx of mid-metacarpal digit, here disproportionately large as compared with the bones of the other two phalanges.

Pollex phalanx is small, slender, and trihedral in form; it is not provided with a claw at its distal extremity.

A very similar joint is the distal phalanx of index digit, and this, too, is without a terminal claw.

The proximal bone of this finger has the general form it assumes among birds, but in the present instance the expanded blade-like portion behind is very thin, its surrounding margin only being thickened to lend it the proper support.

When we come to measure the lengths of the bones composing the pectoral limb in this Trogon, we find that the humerus is 3·1 centimetres long, the ulna 3·6; and the skeleton of manus, measuring from the summit of the carpo-metacarpus to the distal apex of the last phalanx of index digit, 3·0 centimetres long.

Of the Pelvic Limb (Pl. XIX. fig. 13).—Trogons have a thoroughly pneumatic femur, and a large foramen or two to admit the air are found upon the anterior aspect, near the summit of the bone, between the trochanter and the head. I am not quite certain but that the tibia also possesses a moderate amount of pneumaticity, as the shaft is completely hollow and the bone has the general appearance of a pneumatic one. However, I have failed to discover the presence of the foramina in this part of the skeleton of the leg. As for the fibula and the remaining skeletal parts of this limb, they are entirely devoid of this feature.

Returning to our examination of the femur, it is to be noted that the trochanter is but feebly pronounced, and does not rise above the summit of the bone. The caput femoris is globular and quite sessile with the shaft. We can scarcely discern any pit whatever upon its superior surface to lodge the attachment of the ligamentum teres. Descending to the shaft we find this part of the bone nearly cylindrical in form, very smooth, and quite straight. At its distal extremity the condyles are rather small comparatively; the external one being situated lower, and at the same time somewhat more prominent than the internal one.

Trogons possess a very well-developed *patella* of a subcordate form, it being fully twice as wide as it is deep.

Regarding the *fibula*, we find that it presents little or nothing worthy of special note. Feebleness of development characterizes this bone in the Trogons throughout. Its head is small and the shaft slender, the lower end of the latter being free from the tibia, and descending to a point about opposite the junction of the middle and lower thirds of its shaft. Scarcely any evidence exists of the presence of the tubercle for the insertion of the tendon of the biceps muscle, a feature which is quite prominent in some birds.

Next, passing to the consideration of the *tibia*, we find its shaft to be nearly straight, being but slightly convex forwards; while for the greater portion of its midcontinuity it is of a subcylindrical form, changing only as it approaches its enlarged extremities. At the proximal end of the bone the pro- and ectocnemial ridges on its anterior aspect are considerably suppressed, and soon merge into the shaft below; they are nearly of equal size, and the cnemial crest above them does not rise above the tibial summit.

Although the condyles at the distal end of the bone are very similar to these protuberances as they are commonly found in the majority of small birds, they are yet peculiar in having between them, below and behind, a mid- and well-marked longitudinal ridge, constituting a feature that at this moment I do not remember to have noticed among the tibiæ of the class.

On the anterior aspect of this tibia, just above the condyles, we notice the usual longitudinal tendinal groove, spanned at its lower part by an osseous bridgelet thrown directly across it.

The *tarso-metatarsus* has a length equal to rather more than half the length of the tibia, while the calibre of its shaft is about one third less than that of the latter bone. This tarso-metatarsal shaft presents three plane and ungrooved surfaces, an anterior one and two lateral, or rather postero-lateral, ones. The summit of the bone is moulded in the usual manner for articulation with the tibial condyles. Behind the proximal extremity of the bone we find a fairly well-developed hypotarsus, vertically pierced by two tendinal canals placed side by side.

Passing to the distal end of the tarso-metatarsus, we find the trochleæ so disposed as to accommodate themselves to the zygodactyle condition of the podal digits, which consists, as we know, in Trogons of a permanent reversion of the second toe.

These digits have their bony phalanges arranged upon the most usual plan as we find it in the vast majority of living birds, *i. e.* 2, 3, 4, and 5 joints for the first, second, third, and fourth toes respectively.

Considered as a whole, although the skeleton of the foot of this bird is in due proportion with the rest of the limb, it nevertheless strikes us as being rather a delicately formed structure. The accessory metatarsal possesses a shape usually assumed by it among birds, but in the present instance makes a very close articulation with the shaft of the tarso-metatarsus at its most usual site.

Measuring the lengths of the several bones of this pelvic limb, as we did in the case of the pectoral one, we find that the femur is 2·3, the fibula 2·1, the tibia 3·3, and the tarso-metatarsus 1·6 centimetres long.

Without measuring the several lengths of the joints of the pedal digits of a Trogon, I am enabled to say that they are quite as harmoniously proportioned as are the corresponding phalanges of the average foot of any Passerine bird that I have ever examined.

This completes my description of the skeleton of *T. mexicanus*, and, as observed, it will apply with almost equal exactness to the skeleton of *T. puella*. In proceeding with my account I have been careful, I believe, in every instance to point out any constant character that seems to distinguish them; and no doubt my description will practically answer for other nearly related species of this handsome group of birds.

It seems scarcely necessary to tabulate the salient features of the osteology of this Trogon here, as my brief account presents but little more than an enumeration of the essential characteristics. It will therefore be omitted, in the belief that the several figures illustrating my text and the description will be amply sufficient even for convenience of reference.

Comparing these osteological characters of *Trogon* with the corresponding ones of such a Humming-bird as *T. Alexandri*, as I presented the latter in my former memoir, P. Z. S. 1885, it will at once become evident to us that, so far as the skeletology of the two forms is concerned, there is absolutely little or nothing that mutually characterizes them.

So much for the comparative osteology of Humming-birds and Trogons, but this will not exactly apply to some other groups of birds, such, for example, as the Cuckoos and Nightjars; and I will now proceed to draw a few comparisons among some of them.

I regret to say that the only Cuckoo-like bird I have at hand is *Geococcyx californianus*, and, as stated above, I have already published an account of its osteology in the 'Journal of Anatomy.' I did have, not long ago, a fairly good skeleton of the Yellow-billed Cuckoo (*Coccyzus americanus*); but Prof. Parker was at that time in search of all the Cuculine birds he could procure, and it gave me great pleasure to forward it to him along with a few others that I had collected, in response to his request for such material.

The characters of that skeleton have escaped me, but the reader can easily compare such forms as he may have at hand with what follows.

My former memoir (P. Z. S. 1885) contains an extensive account of the osteology of *Chordeiles* and *Phalænoptilus*; so in the present connection I may point out what has been already ascertained in regard to a comparison of these Caprimulgine forms and *Geococcyx* with the Trogons. Thanks to my friend Mr. Sage I have before me a fine alcoholic specimen of our American Whip-poor-will; but I do not intend to dissect that until we enter upon the next section of this memoir, wherein it will constitute my type for the general anatomy of a Caprimulgine bird.

A comparison of the skulls of *Trogon*, *Chordeiles*, and *Geococcyx* need not detain us long, for they have but very few characters in common. With respect to the skulls of *Trogon* and *Geococcyx* they may be dismissed by stating that they differ from each other in every essential particular, beyond the fact that they are both skulls of birds.

This difference is quite as great when we come to compare the skulls of *Chordeiles* and *Geococcyx*, for here, too, it would be very difficult, if not quite impossible, to pick out a single feature in the one that would in any way be comparable to the corresponding one in the other.

Except for the fact, as stated, that they are both skulls of birds, they are totally unlike.

Not nearly so much so is this the case with *Trogon* and *Chordeiles*; for, different as the skulls of these two forms really are, I think I can see a certain resemblance between them, slight as it is.

Still even here, at the best, it is little more than a superficial likeness; they have, however, in common the basipterygoidal processes, if nothing beyond that. Their mandibles, as we know, are entirely dissimilar. Notwithstanding this, it would be far easier for us to conceive that a Trogon's skull was a very much modified Caprimulgine one than it would be to picture any relation between it and the skull of *Geococcyx*.

With these facts before us we are not surprised to find, what is really the case, that the osseous hyoid arches of these several types are also of very different patterns, and do not suggest to us any special relationship of their owners.

To sum up then, so far as the skulls of these birds are concerned. Had we no other part of their structure to guide us, I think we should be fully justified in placing them in separate orders of birds. But let us still further compare the characters of their osseous structures and pass to a consideration of the remainder of their axial skeletons.

First let us take a glance at the number of vertebræ in the spinal columns of the several birds in question, irrespective of any special characteristics these vertebræ may possess in themselves. For I wish it to be distinctly understood that although

Species.	Number of vertebræ in the cervical portion of the column that are without free ribs.	The first vertebra that bears a pair of free ribs.	The first vertebra whose ribs connect with the sternum by costal ribs.
Trogon mexicanus	12	13th (without unciform processes).	14th
Chordeiles texensis	11	12th (with unciform processes).	13th (14th in *P. Nuttalli*).
Geococcyx californianus	12	13th	15th

Species.	Number of dorsal vertebræ connecting with sternum.	No. of vert. in sacrum and the sacral ribs.	No. of free tail vertebræ, including pygostyle.
Trogon mexicanus	4 (and one more dorsal vert. that does not so connect, making 5 dorsals).	12 There is one pair of sacral ribs.	7
Chordeiles texensis	3	10 sacral ribs join sternum.	6 (5 in the Whip-poor-will)
Geococcyx californianus	3 (and one more dorsal vert. that does not so connect).	11	5

I place the just amount of weight that should attach to the *number* of these segments in the spinal column of any bird, I think it should be borne in mind that these vertebræ are as much entitled to be considered in the light of the special form each or any of them may assume, as is any other part of the skeleton.

The day may yet come when the question of the exact affinity of avian forms (or any other class of vertebrates for that matter) will have arrived at such a point of refinement as to require that even the morphology of *each vertebra* shall be known, to assist us in correct decisions. In the table which I here introduce (p. 335) the number of ribs and some few other points which I deem it well to compare have been entered.

So far as we are able to judge by a comparison of these, it would seem that, taking into consideration the kind of data presented, *Trogon* comes nearer to *Geococcyx* in its vertebral column than it does to any of the Caprimulgi. But it must be remembered that it is really very difficult to discern any truly striking resemblances among the vertebral columns of the several birds under consideration.

Turning to the *pelves*, we find on comparing the pelvis of *Trogon* with that bone as we find it in some of the Nightjars and Whip-poor-wills, that there is a certain superficial likeness which strikes us; but when we descend to the comparison of details, we are again met by the fact that these resemblances are purely superficial. Of course neither the pelvis of *Chordeiles* nor *Trogon* reminds us in the least of the unique pelvis which so conspicuously characterizes the skeleton of *Geococcyx*. How they would compare with certain other Cuckoo-like birds I am unable at present to say, from lack of proper material on which to form an opinion.

Passing to the *sternum* (and I have figured this bone for both *Chordeiles* and *Geococcyx* in my memoirs above referred to, and for *Trogon* in the present paper), we are at once struck by the resemblance between the sterna of *Trogon* and *Geococcyx*; the bones here are really very much alike, and both are essentially different from the single-notched sternum of *Chordeiles*.

Coming next to the *shoulder-girdles*, we are once more at sea, for these parts not only have no special likeness to each other, so far as *Trogon* and the Caprimulgi are concerned, but both, on the other hand, are extremely unlike the pectoral girdle as we find it in *Geococcyx*.

These remarks apply with equal truth and force to the *pectoral* and *pelvic limbs* of the several forms under examination; and even in the case of the reversion of the toes in *Trogon* and the Ground-Cuckoo, we are all aware that in the former bird the second toe is turned back, while in the latter it is the fourth one that is reversed.

I agree entirely with Professor W. K. Parker when he states that "the familiar term 'zygodactyle' for birds with a certain form of foot has been very useful; and yet how much ignorance it may be made to hide! It seems to be something when one knows that a certain bird belongs to that group; and yet a Cuckoo, a Parrot, and a Woodpecker come none the nearer each other zoologically by the possession of that kind of foot"*.

To recapitulate then, and judging from the *skeletons alone*, we must see that such a form as *Geococcyx californianus* is more or less remotely related to such birds as *Alcedo* and *Dacelo*, perhaps much nearer them than it is to the true Tree-Cuckoos. In saying this I am aware that in a paper recently read for me before the Zoological Society I was still inclined to support the classification of Garrod, who divided the *Cuculidæ* into two subfamilies, viz. the Ground-Cuckoos (*Centropodinæ*) and the true Cuckoos (*Cuculinæ*) (P. Z. S. 1874, p. 121); and this paper of mine referred to the anatomy of *G. californianus*, but at the time I had no specimens of true Cuckoos to compare it with. Still I am inclined to adhere to that opinion until I have had an opportunity of making further researches into the structure of many other types more or less nearly related. On the face of it I should be disposed to think that *Geococcyx*, so far as its skeleton is concerned, came nearer to such a form as *Dacelo gigantea* than to *Cuculus canorus*, for instance, notwithstanding the structure of the foot. But many of these interrelated groups are exceedingly puzzling, and still require a considerable amount of original investigation of their morphology.

Of the Caprimulgi, of course, I shall have more to say further on; it is very evident, so far as their osteology indicates, that they are very widely separated from the Trogons.

And now as to the Trogons themselves, still being guided by

* Parker, W. K., "On the Morphology of the Skull in the Woodpeckers and Wrynecks," Trans. Linn. Soc., Zool. 2nd ser. vol. i. pp. 1–22.

the skeleton alone, it is very plain that they have no special affinity with the Trochili.

When my eyes first fell upon the skeleton of one of these Trogons, as I have already stated, the remark was forced from me that they were "Caprimulgine Cuckoos." First impressions, however, are not always to be relied upon, for, apart from the general likenesses of their sterna, and having the same number of cervical vertebræ without ribs, from skull to pygostyle, and from pinion to pes, so far as the skeleton goes, *Trogon mexicanus* has nothing whatever to do with *Geococcyx californianus*, and, as stated, I have no true Cuckoos to compare it with. I dare say that if related to the Cuckoos at all, it is more than likely to be nearer these latter in its osteology. I have not had the opportunity, as yet, to examine the skeletons of either *Crotophaga* or *Scythrops*.

Beyond a few apparent resemblances I find nothing in the skeleton of the Trogons that in any way points to their being related, even remotely, to the order Caprimulgi; and it seems to me that there must be a considerable gap between the Trogons and Kingfishers.

The Anatomy of certain Caprimulgi.

Glancing at our list of material, we find that we have but a few American forms to illustrate the structure of this highly varied group of birds. There is an alcoholic specimen of the common Whip-poor-will, a couple of skeletons of the Nuttall Poor-will, and several species of *Chordeiles*, both in alcohol and skeletons.

In my first contribution in the P. Z. S., relative to the structure of the Caprimulgine types, I gave a very full account of the osteology of *Chordeiles*, with a number of figures, as well as a description of the skeleton of Nuttall's Poor-will. I am convinced that when the hundred or more species composing this order come to be carefully examined as regards their structure, there will be not only some very good characters brought to light, but considerable difference found in the economy of the forms composing the group.

Among the notable departures it will be remembered that in my first contribution to their structure I found the arrangement of the bones of the palate entirely different in the Nightjars and true Whip-poor-wills.

As the external characters of these commoner American forms are well known, and are fully set forth in general works upon ornithology, I need not introduce them here.

Suffice it to say that these characters fully rank as *ordinal* ones in so far as they distinguish these birds from either the Swifts or the Humming-birds.

When I say ordinal ones I mean as pertaining to an order in the sense which that division holds as applied to Avian taxonony, and not to other vertebrate classes, where, as we know, structural differences are far greater than are to be found even among the extremes in the class *Aves*.

Having gone carefully over all the literature and material now available that bears in any way upon the present group, I find no reason to change my opinion as originally set forth in my memoir published in the Proc. Zool. Soc. 1885, where I proposed (p. 914) that all the Caprimulgine birds should be considered as constituting an order—the order Caprimulgi. I mentioned a number of the more doubtful forms that should be admitted to this order, as *Nyctibius*, *Steatornis*, *Podargus*, and others. Scarcely a doubt exists now, I think, in regard to the relation these birds bear to the Owls, through *Steatornis*, and, further, they have no particular affinity either with the Humming-birds nor the Swifts.

Their morphology is full of interest, and will repay very careful research in the future.

In the present connection it is my intention to lead off with a full description, if the one fine specimen in my possession will admit of it, of the anatomy of our common American Whip-poor-will (*Antrostomus vociferus*), making it comparative with the more aberrant genus *Chordeiles*, and then add something further in regard to the skeleton of *Phalænoptilus Nuttalli*.

On the Pterylographical tracts of Antrostomus *and* Chordeiles *(omitting the remiges and rectrices).*

Having carefully plucked my specimen of *Antrostomus vociferus* and one of *Chordeiles texensis*, and opened before me my copy of Sclater's edition of Nitzsch's 'Pterylography' at the proper page and plate (p. 87, pl. iv. figs. 1 & 2), I am prepared to present a few remarks upon the pterylosis of the Caprimulgine birds in my hands.

Commencing with the pterylosis of the head, I find in *A. vociferus* the same character which Nitzsch points out for the European Whip-poor-will (see Pl. XVIII. figs. 9 and 10 of this paper), and that is, on its superior aspect there is a triangular patch filling in the space just posterior to the superior mandible. Behind this the feathers form a median longitudinal tract of some width, which, extending down the back of the neck, as the dorso-cervical tract, forks between the shoulder-blades. Between this median tract on the top of the head and within the superior eyelid, on either side, we find a double longitudinal tract of contour feathers which join those in front, and posteriorly unite with the pterylosis of the inferior aspect of the head or the throat. Apteria occupy the interspaces among these supra-capital, longitudinal pterylæ on the head of this Whip-poor-will, and as a distinctive feature it is even better marked in our specimen of *Chordeiles*.

It will be remembered that Nitzsch figured this character for *Caprimulgus europæus* and *Nyctornis grandis*, while he states in the text that he compared these two forms with *C. longipennis*, *C. forcipatus*, and *C. psalurus*. He also examined pterygraphically *Ægotheles Novæ-Hollandiæ*, *Podargus gigas*, and *Nyctornis æthereus*.

On the throat of the Common American Whip-poor-will the feathers are arranged in fairly well-defined, longitudinal rows, and Nitzsch found this to be characteristic also of the European bird; but in *Chordeiles* these rows are not very easily made out, if the throat-feathers are inserted upon any definite arrangement, and I am inclined to believe that in this latter form this is not the case.

Anteriorly the cervical region is densely feathered in both *Antrostomus* and *Chordeiles*, the tract extending to the points opposite the clavicular heads of the *os furcula*, laterally; while mesially an aptera occurs of no great extent between the forks of the bone just alluded to (fig. 9).

Nitzsch found a different state of things in this region in the European Nightjar, for he draws the entire antero-cervical space without feathers, which reduces the neck-tracts to two longitudinal, *lateral* pterylæ*, as shown in his figure of that bird.

The superior mandibular bristles in the Whip-poor-will before me are conspicuously long, and are deeply inserted as a single

* "Feather-tracts," from πτερόν and ὕλη.

row just within the margin of the gape. These bristles gradually increase in length from before backwards, the posterior one being nearly 4 centimetres long. A few short and straggling ones are also found in the gular space beneath. In the Nightjar these bristles are very short, both above and below, and are by no means a striking feature in this bird, as they certainly are in the *Antrostomus*.

Returning to the dorso-spinal tract in the last-named specimen, we find the extremities of the forks between the shoulder-blades, already alluded to above, joined by the ends of a similar but counter-disposed fork, coming, as it were, up from the lumbar region. From the apex of this latter the spinal tract appears to be more or less distinctly divided into two parallel rows, the median space between them being filled in with less regularly arranged feathers. Posteriorly the oil-gland stands between these rows, which slightly diverge as they reach it. This course of the spinal tract evidently creates a lozenge-shaped pteryla between the shoulder-blades, and this is even better marked in *Chordeiles*. The apteria or "featherless spaces" on the dorsal aspect of these birds are very sparsely covered with feathers to the extent shown in figure 10.

Now Nitzsch found quite a different arrangement of the spinal tract from this in the European Nightjar, as may be seen from his figure, and the words of his text, where he says, "spinal tract at first broad, forked between the shoulder-blades, each branch united to the broad rump-band by a single row of contour-feathers."

We must, however, recollect that this eminent naturalist also stated that these tracts differed "in the various genera."

A curious departure is seen in *Chordeiles texensis*, where, on either side, a broad tract joins the hinder apex of the lozenge-shaped dilatation of the spinal tract with the posterior extremity of the ventral band of the corresponding side. The course of this broad connecting band is directly beneath the "armpit."

Speaking of the "oil-gland" in these birds, Nitzsch says it "is remarkably small, probably the smallest in proportion that occurs in the whole class of birds; it is of an elongated oval form, without a circlet of feathers at the tips" (*op. cit.* p. 87). This description applies in every particular to the two American forms of Caprimulgi before me.

As shown in Pl. XVIII. fig. 10, the "femoral tracts" are very definitely marked in *Antrostomus*; they are broader and more diffuse in *Chordeiles*. The feathering of the integuments of the pelvic limbs of either of these genera is somewhat sparse and scattered, and without definite pattern.

Turning now to the ventral aspect of the body, we find, in common with what Nitzsch found in *Caprimulgus*, that in these American forms the anconal surface of the wings are very thickly feathered all over; the feathering becomes scattered as we pass on to the patagium; but the free anterior edge of this latter membrane has a narrow and dense row of small feathers inserted along its entire length.

I have already described above the pterylosis of the anterior cervical region; this leaves us to consider the feathering of the pectoral aspect of the body. Here we find that both *Antrostomus* and *Chordeiles* agree very closely with the European Nightjar, as the pterylosis of that bird has been described by Nitzsch.

The ventral tracts in all are broad, broader than the well-defined humeral tracts of the dorsal aspect, being rather widely separated in front, and blending somewhat with the aforesaid humeral tracts at the summit of either shoulder.

The median apterium of the chest (if we may apply this term to it here) is uniformly, though thinly, feathered in both *Antrostomus* and *Chordeiles*, which sparse feathering is extended over the abdomen below. This condition is not taken into consideration by Nitzsch in his figure of these parts in *Caprimulgus*. From the posterior extremity of the broad ventral tract on either side in the Whip-poor-will and Nightjar we find a narrow contour abdominal tract running backwards on a curved line to join the fellow tract of the opposite side behind the vent.

The pelvic limbs are fairly well covered with feathers upon this aspect, though not so much so as they are upon the reverse sides.

So much, then, for the pterylography of the Caprimulgine birds now under consideration. After the detailed way in which I have attempted to describe it in the above paragraphs, it will be hardly necessary to present synoptical tables of differences or similarities to be found in the two American genera examined. The principal facts to bear in mind are that the pterylosis of the American *Antrostomus vociferus* differs from the pterylosis of the European bird as described by Nitzsch in a few well-marked particulars, and that both of these forms again differ in this particular from *Chordeiles*, to say nothing of the further departures which we find when we come to compare both Whip-poor-wills and Nightjars with such types as *Nyctornis grandis* and some others.

No doubt further on we shall find that still more striking differences in pterylosis exist among the Caprimulgi and the Swifts and Humming-birds, to say nothing of what may be discovered between the last two groups in this regard.

Before concluding what I have to say about this character in the Caprimulgi, it should be observed that although they differ among themselves in their pterylography, there is a certain general similarity of pattern in them all, the fundamental characters of which are probably well exemplified in our *Antrostomus*, as shown in figs. 9 and 10; while the departures from it may be easily made clear and apparent by the most superficial comparison of the several genera, as I have attempted to point them out or directed attention to those already described by Nitzsch.

Observations on the Anatomy of Antrostomus *apart from the Skeleton.*

(*Comparisons with* Chordeiles.)

Thanks to the labours of Huxley, Müller, Nitzsch, Macgillivray, Cuvier, Garrod, and Forbes, and to an admirable paper by Mr. Frank E. Beddard, the present Prosector to the Zoological Society of London (P. Z. S. 1886, p. 147), much is already known of the anatomy of the most prominent representatives of the order Caprimulgi.

In the present connection I shall attempt little more than a verification of the observations of these trustworthy writers by dissections of the material I have at hand, and thus fill in the scheme of my memoir.

First, then, in the two specimens before me, with a scalpel I carefully remove the integument entirely from the head and down as far as the root of the neck. This done, the first thing that strikes us is that we can easily discern the form of the superior aspect of the brain even through the skull-walls, which have here been rendered more or less transparent by soaking in alcohol. It will be observed that the brain of *Chordeiles* is considerably larger than the brain of the Whip-poor-will, notwithstanding the fact that in the latter bird the skull is markedly wider, longer, and flatter; while in the Nighthawk the parietal region of the skull is more dome-like and rounded. The eyes in the Nighthawk are rather larger than they are in the Whip-poor-will; while in the latter the recurved limbs of the hyoidean cornua are longer, more median, and reach higher up on the cranium than they do in *Chordeiles*.

Marked differences of course characterize the skulls of these two forms; but of this we shall have something to say later: the inter-ramal layer of muscles is thicker in *Chordeiles* than it is in *Antrostomus*, completely shutting out of sight the hyoidean apparatus in the former bird, while its form can be easily made out in the last-named type through this muscular layer.

We need not enter here upon a comparison of the structure of the neck in these two birds, but proceed at once to remove the skin from the body and limbs.

On the Mode of Insertion of the Patagial Muscles of the Pectoral Limb.

These I not only examined in the specimens before me of *Antrostomus* and *Chordeiles texensis*, but in a number of other species of the latter genus, with the following results. Our American Whip-poor-will, I find, has the tendons of these patagial muscles of the arm inserted in precisely the same manner as Garrod found them in *Caprimulgus europæus*, see either in his "Collected Memoirs," or in my copy of his figure in my "Contributions to the Anatomy of *Geococcyx*" (P. Z. S. 1886, p. 471). But it will be as well to mention here that these tendons are far more slender than one would be led to suppose from this anatomist's drawing alone. They are exceedingly delicate in structure. This remark, however, does not so well apply to these tendons of the patagial muscles as we find them in the genus *Chordeiles*; here they are decidedly broader and stronger than they are in the Whip-poor-will, and also present certain well-marked differences. Now, although the plan of arrangement is essentially the same in the Nighthawks, we find that the tendon (the main tendon) of the tensor patagii brevis is evidently composed of two longitudinal slips coming off from the distal apex of the muscle together, they being but lightly held together, as they descend towards the muscles of the forearm, by a delicate connective tissue. The anterior or distal division of this double tendon is the one which becomes inserted in the *extensor metacarpi radialis longior* muscle of the forearm at the juncture of its tendon and fleshy part. The inner slip of the main tendon of the tensor patagii brevis, or the slip next to the humerus, is directed as in the Caprimulgi generally. In other words, the arrangement here is the same, only the tendon of the muscle makes it appear somewhat different from the arrangement in the Whip-poor-will, upon dissection, from the fact that in the main tendon the two slips are so evidently distinct. Both of these birds possess the "bicipital slip," shown by Garrod to be present in the Caprimulgi.

There is yet another point, however, present in the Night-hawks which I have failed to find in the specimen of *Antrostomus* before me. It is this: when the tendon of the *tensor patagii longus* muscle comes to be about opposite the points where the slips of the tendon of the *tensor patagii brevis* are inserted into the structures of the forearm, it sends off a delicate little tendinous slip which is inserted upon the *extensor metacarpi radialis longior* muscle, at the same point where the distal slip of the tendon of the last-named muscle is also inserted, *i. e.* at the point of union of its tendon and corneous portion.

On reading over this short description as detailed in the last few paragraphs, it seems hardly necessary to give any figures to make my remarks the clearer; it will be well to note, however, that among the North-American Caprimulgi at least—and it will undoubtedly hold good for the entire group,—the method of insertion of the slips of the tendons of these patagial muscles of the arm may differ for the several genera very appreciably, and on proceeding with my dissections of *Antrostomus* and *Chordeiles* I am the more convinced that, *as genera*, they are very well-marked ones.

Of the Pectoral Muscles.

Both in *Antrostomus* and *Chordeiles* all three of the pectoral muscles are present. *Pectoralis major* and *pectoralis secundus* are in each case very well developed, while *pectoralis tertius* is quite small and insignificant in comparison even with the second pectoral. It arises mainly from the shaft of the corresponding coracoid, and only the extremities of its most posterior-reaching fibres arise from the sternum, and not as in many other birds, where a proportionately good share of its bulk may spring from this last-named bone.

All these pectoral muscles are inserted into the humerus in a manner common to the great majority of the class Aves, and require here no special remarks upon that point.

Notes on the Anatomy of the Pelvic Limb.

When examining that group of muscles of the thigh used so successfully by him in classification, Garrod dissected specimens of *Caprimulgus europæus* and *Chordeiles texensis*, almost identically the same forms as those before us. In them he found that they possessed the "femoro-caudal, the semitendinosus, the accessory semitendinosus, and the postacetabular portion of the tensor fasciæ;" but "the ambiens and the accessory femoro-caudal are absent." (Coll. Mem. p. 192.)

My observations tend to confirm these results for the genus *Chordeiles*, and enable me to say that the same statement holds good for *Antrostomus*; both limbs of the birds before me were carefully examined, and all the muscles of the thigh dissected out. I also saw that the main artery of the limb was the *sciatic*, as it is in the majority of birds.

Passing next to the foot, I dissected out the *plantar tendons* of both feet in the Whip-poor-will, and the same parts in both feet of *Chordeiles texensis* and *C. texensis*, var *Henryi*.

Here again I can confirm the observations of Professor Garrod, who found that in *Caprimulgus europæus* "the two deep flexors descend beyond the ankle-joint independently, as usual; after passing which, generally about one third down the tarso-metatarse, they blend completely *before* any slip has been given off. From the conjoined tendon thus formed, the tendons of distribution spring, four in number, one to the hallux and others to each of the three anteriorly directed toes (see Collected Memoirs, fig. 4, p. 292), that to the hallux being generally separated off before any of the others." (*Op. cit.* p. 294.)

It struck me, however, that in *Chordeiles* the tendon of the *flexor longus hallucis* enjoyed a greater degree of freedom than had been found by the anatomist just quoted to exist in *Buceros rhinoceros*, which I believe to be as he found it in *Caprimulgus*; as in *Chordeiles*, it is easily separable from the deep flexor *along its side*, thus approaching somewhat more nearly the condition as found in *Momotus lessoni*.

Other Notes.

Cuvier, Nitzsch, and Beddard (P. Z. S. 1886, p. 147) have all made careful examinations of the syringes of the *Caprimulgi*; and the tracheo-bronchial syringes of *Caprimulgus* and *Chordeiles* are well known. I have investigated this part of the anatomy of the forms before me, and find they agree in all particulars with the descriptions given by the above authorities; all of which will obviate the necessity of my entering upon further details here. Beddard's paper, just alluded to, is a real contribution to the anatomy of these parts for the Caprimulgi, and will well repay reading in the present connection.

Antrostomus has two carotids present, taking the usual course up the neck in the mid-vertebral canal. This agrees with what is already known for *Caprimulgus* and *Chordeiles*; and I verified the fact in the latter bird in the specimen at hand.

Intestinal cæca are present in both *Antrostomus* and *Chordeiles*, being in each case a long slender pair (fully 4 centimetres in length), and each about one half the calibre of the intestine to which they are attached.

Upon investigation I find that *Antrostomus* possesses a small gall-bladder, while the several species of *Chordeiles* lack this organ: this confirms the observations of Mr. Beddard, who found that in the latter case Garrod had also left a MS. note to that effect (P. Z. S. 1886, p. 151).

The form of the œsophagus and stomach is pretty much the same in both the Whip-poor-will and Nighthawk, although as regards size it is comparatively larger in the latter bird. I find it to be a flask-shaped pouch, somewhat compressed from side to side, with the walls of a fairly uniform thickness, and composed of strong rugæ. These, commencing at the lateral tendinous centres at either side, curl round and round in double loop until they come to the œsophageal tube, which they ascend for a short distance and upon which they are gradually lost. These rugæ are so well marked that they may be easily discerned from an examination of the external surface of the stomach; and upon the dorsal aspect of the organ they seem to rise into a sort of transverse ripple, a character present also in the Whip-poor-will. The œsophagus is of large calibre in these birds, and, as stated, thick and firm as it approaches the gastric pouch.

The small intestine is delicately constructed, and not especially large as it passes from the wall of the stomach at a point situated at the upper right side of the organ, not far from where the œsophageal tube enters.

Inside the stomach the gastric rugæ are covered by a moderate layer of corneous tissue, composing about one third the thickness of the stomach-wall, which may best be seen upon a section of the organ.

Of the Osteology.

For the purposes of classification I gave in my first memoir on the present subject (P. Z. S. 1885) sufficiently full descriptions of the skeleton in specimens of *Chordeiles* and *Phalænoptilus Nuttalli* for all that is required in the present connection; so it will be only necessary here to make some additional remarks upon the skeleton as found in my specimen of *Antrostomus.* Judging from the figure of the base of the skull of the common European Nightjar, which I copied from Huxley and reproduced in my first memoir, I should say that, osteologically, the American form of this bird was very much like it in that particular system of its anatomy; indeed, I expect that structurally the two forms are very similar. Then, as one would naturally have expected, I have found, upon a mere superficial comparison, that osteologically the common Whip-poor-will and Nuttall's Poor-will (*P. Nuttalli*) are very much more alike than either of them resemble *Chordeiles.* In fact, it takes but a glance at a skeleton of a true Whip-poor-will and a Nighthawk to convince us at once of the marked differences that exist between them. As I have elsewhere said, these two genera of Caprimulgine birds are separated structurally by very excellent characters of a nature at once recognizable.

Figures in the plates of my first memoir, above alluded to, also illustrated the skull of a *Chordeiles* and the principal bones of its skeleton; and for further description these will answer all the purposes required. In the present paper, however, I have thought it best, for the sake of completeness, to add three figures of the skull of Nuttall's Poor-will (*P. Nuttalli*) in order to show how well it agrees with *Caprimulgus* and *Antrostomus*, and differs from the skull in *Chordeiles* given in my former memoir (Pl. LIX. figs. 1, 2, and 4).

Upon more careful and extended examination, I find that, except in point of size, *Phalænoptilus* being about one third less than *Antrostomus*, the skulls, mandibles, and hyoidean apparatuses of these two forms are very much alike indeed, in all essential particulars. And as the characters of the skull of the Whip-poor-will are well known, and, further, as I present herewith figures in the Plate of the skull of the Poor-will, I believe that any further comments upon this part of the subject would be superfluous.

One point, however, in respect to the hyoid. In my former paper I made the statement that in it the basibranchials in Nuttall's Nightjar were in two pieces. This was true for the specimen examined, although in the skeleton of *Antrostomus* before me these parts are anchylosed together, which may be the case in all old birds of both these genera. *Chordeiles* has them in one piece; and I am led to believe from this that it will be found to be generally the case in our N.-American Nightjars.

Passing next to the remainder of the axial skeleton in *Antrostomus*, I find my account of the corresponding parts for *Chordeiles* and *Phalænoptilus Nuttalli* (P. Z. S. 1885, p. 903) to be so complete that it leaves but little here to be added.

Upon carefully re-comparing the axial skeletons of the three genera *Chordeiles*, *Phalænoptilus*, and *Antrostomus*, now in my hands, it confirms my previous notions as to their agreements and disagreements; and, as one would naturally expect, the skeletons in the two Whip-poor-wills, or rather the Whip-poor-will and Nuttall's Poor-will, are most alike.

The skeleton in a specimen of a Nightjar has already been described in the place just alluded to; and now I find that *Antrostomus* agrees with *Phalænoptilus* in having *eleven* vertebræ in the cervical division of its spine before we come to that which is the first in the column to have free ribs attached to it. These ribs in the Poor-will, however, are described as being rather long;

whereas in the specimen of the Whip-poor-will before me they are quite rudimentary and small, although they have both head and tubercle.

For the rest of the vertebral column in these two birds, they practically agree, both in number and arrangement of the ribs and vertebræ. Their *pelves* are also very much alike, and wear the same pattern for general outline, even to the pointed and in-turned anterior tips of the ilia, which latter feature constitutes a very excellent character for this bone, at once distinguishing it from the pelvis of a *Chordeiles*.

Antrostomus also agrees with the Poor-will in having but *five* free vertebræ and a pygostyle in the skeleton of its tail; whereas it will be remembered that the several species of *Chordeiles*, as a general rule, have *six* and a pygostyle. I have yet to find an exception to this statement. All three genera seem to possess *ten* vertebræ in the series that anchylose together in the pelvis.

In *Antrostomus* in the dorsal series of vertebræ, as in all the Whip-poor-wills and Nightjars which I have examined, the hæmal spines are comparatively long and conspicuous, the anterior ones being trifurcate at their extremities.

Essentially the form of the *sternum* in *Antrostomus* agrees with the same bone in *Phalænoptilus*, and the general form it assumes for the true Caprimulgine birds is very well shown in the figure I gave of the sternum of *Chordeiles texensis* in plate lxi. of my first memoir, which can be referred to in the present connection. With three specimens of this bone before us, one being chosen from each of the three genera in question, they may be in general distinguished by the following characters :—The sternum of *Chordeiles* is the largest of the three, and that of *Phalænoptilus* the smallest. The "costal processes" in the Whip-poor-wills are simple erect spines (best marked in *Antrostomus*)· whereas in the Nightjar they are more like laterally-compressed plates, and as we find them in many other birds. All three have the pair of deep rounded notches in the posterior end of the body of the bone. They are all without manubrial processes.

The *shoulder-girdle* in *Antrostomus* is very like those parts as I have already described them for Nuttall's Poor-will, being only proportionately larger.

Turning, now, to the *pectoral* and *pelvic limbs* in this American Whip-poor-will, we find that they also essentially agree, except in point of size, with the corresponding bones and parts in *Phalænoptilus Nuttalli*, those in *Antrostomus* of course being the larger.

With a skeleton of the latter bird now before me, and carefully reading over my descriptions of the limbs of *Chordeiles* and *Phalænoptilus*, as I gave them in my first memoir on this group, I find that there is nothing special to add to that account; all the essential characters of these parts being duly presented for the American forms of Whip-poor-wills and Nightjars.

There is one more statement I made there that seems, however, to demand correction; for in describing the proximal phalanx of the index digit of the manus I said of its expanded portion in *Phalænoptilus*, that of the two perforations which were found in it in *Chordeiles*, they merged in the former bird "into one large one." This is not so; for upon a more extended examination I find that there are always *two* perforations in this part of the bone in *all* the forms we have been considering.

This is all I have to state in regard to the descriptive part of the structure of the Caprimulgine birds of the United States. Should it become necessary further on to fall back upon this descriptive part, for the sake of comparison with the remaining groups yet to be described, it will be done; but, so far as I am concerned, I am firmly convinced that, taken as a group, including all other Whip-poor-wills and Nightjars, and such forms as *Nyctibius*, *Psalurus*, *Steatornis*, and *Podargus* and others, they are fully entitled to rank as an Order of birds, which I have elsewhere designated as the CAPRIMULGI.

Not having personally examined such forms as *Podargus*, *Ægotheles*, *Nyctidromus* *, *Batrachostomus*, and others, I am not fully prepared to offer an opinion as to the families and other divisions of such an Order, nor to state definitely to which other groups the Caprimulgi are most nearly related; but I can hardly agree with Prof. Huxley, who asserts that "the Caprimulgidæ come near *Trogon*, and more remotely approach *Podargus* and the Owls" (P. Z. S. 1867); for believing, as I do, that *Podargus* belongs to the Order, I am also inclined to the opinion that we shall find that, through *Steatornis* and *Podargus*,

* I have since examined skeletons of *Nyctidromus albicollis*, var. *Merrilli* sent me by my collectors in Texas.—R. W. S.

the Caprimulgi are nearer the Owls, and only remotely approach the Trogons.

Again, I can hardly agree with Mr. Beddard *, who would retain such forms as *Antrostomus* and *Chordeiles* in the same "subfamily;" for surely all the essential structural characters of these two forms are of *family* and not *subfamily* rank: a comparison of the skulls alone is almost sufficient to determine this point. And the breach between *Chordeiles* and *Steatornis* must indeed be wider than a mere subfamily line can indicate.

ANATOMY OF THE NORTH-AMERICAN HIRUNDINIDÆ.

From my list of material at the beginning of this memoir it will be seen that I have at hand specimens of every genus and species of Swallow at present entitled to a place in the United-States avifauna, and a sufficient series of each to enable me to fully investigate their structure.

I will take them up, species by species, in the order in which they occur in the 'Check-List' of the American Ornithologists' Union, but need not present a synoptical table of their external characters, for these are well known to ornithologists and ornithotomists the world over.

To commence with them, then, we will take a look at the pterylosis of a specimen of *Progne subis*, compare it with the figures given in my Plate of *Ampelis cedrorum*, and with Nitzsch's drawing of the pterylosis of *Hirundo urbica* in his 'Pterylography,' and next with other American *Hirundinidæ*.

Now it will be remembered that we found the pterylosis of *Ampelis* to agree essentially with most true Passeres, wherein, upon the dorsal aspect of the body, the chief feature is that the "spinal tract" terminates in a lozenge-shaped pteryla situate mesially between the thighs; and on the ventral aspect we have another well-known distribution of the pterylæ characteristic of most Passerine birds. *Progne* differs from all this, and agrees in the main with *Hirundo urbica* as figured by Nitzsch.

This author, however, does not present in his work a ventral view of the pterylosis of a Swallow, but says in his text that "the single genus *Hirundo*, which constitutes this group [*Hirundines*], differs more than any other in its habitus from the general type of the Singing-birds, and in this respect approaches

* P. Z. S. 1886, p. 153.

very closely to some *Cuculinæ*, namely the Cypseli. For this reason I usually place it at the end of the Passerinæ, in the vicinity of the anomalous cuculine form just mentioned, which stands in the same relation to the true Cuckoos as the Swallows to the ordinary Song-birds. However, pterylographically, *Hirundo* does not differ from the rest, but rather harmonizes completely with *Dicæum*, in that the rows of single contour-feathers uniting the saddle with the rump-band are either entirely deficient (*H. rustica, H. urbica*) or indicated only by two rows of very sparse contour-feathers (*H. rupestris*). The dilatation of the pectoral part of the inferior tract is somewhat divergent at the end. The number of remiges is eighteen, of which nine are on the hand, and of these the first is the longest; the first six secondaries are remarkable on account of their broad, emarginate extremities" (pp. 84, 85, 'Pterylography').

Now, in *Progne* I note that the "saddle" at the end of the spinal tract is very broad, although forked as in *Hirundo urbica*, but the posterior extremities of the limbs of this bifurcation are joined, on either side, to the anterior end of the rump-tract by distinct and well-marked rows of contour-feathers. Further, the bifurcation of the "saddle" takes place at about the middle of the back, and not nearly so low down, namely between the thighs, as in *Hirundo*. Another point to note upon this dorsal aspect in *Progne* is that the "alar tracts" are very extensively joined with the anterior endings of the "humeral tracts." In *Hirundo* Nitzsch even seems to leave an unfeathered space, on either side, in these localities. The "capital area" is the same, but in *Progne* there are no naked areas around the eye and auricular orifice, as in *Cypselus*, and as Nitzsch has also drawn them for *H. urbica*.

Under the throat in *Progne* and in most Swallows we find a longitudinal naked strip running down close to and just within the ramus of the mandible, on either side, which terminates at about the angle of the jaw. It will be remembered that in the Whip-poor-wills and others this feature is also present, except in them it assumes a somewhat different type, the feathers of the throat being arranged in regular rows. I am inclined to believe that there is a reason for this, which is, that in these birds, accustomed as they are sometimes to swallow very large insects, an operation which must distend the throat, or even momentarily place the integument there on the stretch, these unfeathered strips would spread to meet the action, but as the parts came to rest again after swallowing, the feathered areas or strips would again become juxtaposed and the throat apparently full-feathered. In some Swallows (e. g. *Chelidon*) these naked strips are only brought fully into view by stretching the integument of the throat.

No special note is necessary to be taken of the ventral pterylosis of *Progne*, as it has all the essential characters of the pattern seen in a Passerine bird, and departs but slightly therefrom. It is more like *Cypselus*, however, than it is like such a form as *Ampelis*, for instance, in that the ventral tract, on either side, overlying the pectoral region, does not show that heavy feathering to its external margin as seen in the latter type. In Swallows, as in all Passerine birds, the oil-gland is nude.

Now I have plucked, with the greatest possible care, an adult male specimen of every Swallow in our avifauna, and the birds are now before me.

In *Petrochelidon lunifrons* the "rump band" on the back is very wide, and is joined anteriorly on either side by a very distinct double line of feathers from the corresponding fork of the "saddle." The ventral bands of the pectoral region are broad but evenly feathered, while on this dorsal aspect the alar tracts meet and blend with the anterior ends of the "humeral tracts." This last feature is invariably the case with all our Swallows, and is best marked in *Clivicola* and *Stelgidopteryx*.

In other particulars *Petrochelidon* essentially agrees with *Progne* in its pterylosis, and with the *Hirundinidæ* generally.

Chelidon likewise has the posterior ends of the saddle-pteryla of the dorsum joined by feather-rows, one on either side, with the rump-band, which latter here is narrow again and strictly defined. Neither this Swallow nor *Petrochelidon* have naked annular areas around their eyes, nor the orifices to their ears. In fact, none of these Swallows possess this last feature. Otherwise, the pterylosis of *Chelidon* is characteristically hirundine.

Neither *Tachycineta bicolor* nor *T. thalassina* have the bifurcations of the "saddle-pteryla" of the dorsum joined with the "rump-band," as in the foregoing forms, but the ventral tracts are here again broad and evenly feathered.

In view, then, of the fact that the pterylosis of the *Hirundinidæ* is pretty well known, it will not be necessary for me to enlarge further upon my account of it.

But the principal thing to be borne in mind in the present connection is, that Swallows, Swifts, and Humming-birds *all* depart from the more typical pattern of pterylosis found in true Passeres. And in the case of the Swallows and Swifts, so far as Nitzsch's figures and descriptions go, for I have not yet examined the Cypseli myself for this character, the pterylosis of the latter is of such a pattern that it requires but very little modification to make it agree with the pterylosis of a Swallow. Indeed, in those Swallows where the "saddle-pteryla" of the dorsum joins its bifurcations with the anterier end of the "rump-band," the pattern is nearly the same, differing principally in relation, width of the tracts, and position of the bifurcation of the saddle, which, in *Cypselus apus*, is between the shoulders.

On the Mode of Insertion of the Patagial Muscles in the Swallows.

Scarcely any difference is apparent among the various species of Swallows at hand in regard to the mode of insertion of this group of patagial muscles, now known to be of so important a character in the taxonomy of the class. I have carefully examined them in all the American species, and find that, so far as the *tensor patagii brevis* is concerned, both its origin and insertion seem to be almost typically Passerine. This observation applies with equal truth to the *tensor patagii longus*; and as these muscles are now so well known to all working morphologists, I need not redescribe them here; moreover, in figure 2 of Plate XVII., I have drawn them for *Ampelis*, which will recall their appearance for the *Passeres*.

During the course of my dissections upon this region in the *Hirundinidæ*, however, I came across, as I did in *Ampelis*, what I am inclined to believe is a hitherto undescribed muscle, at least so far as Garrod's descriptions go. It first came to my notice in a specimen of *Progne subis*, whereupon I at once dissected a number of other individuals of the same species, and found it equally well developed in all of them.

This muscle, in part, is a dermal muscle, and arises from the integuments on the anterior aspect of the neck at about its lower third; at its origin its fibres spread out fan-fashion, their terminal ends meeting those of the muscle of the opposite side in the median line. Here it is quite adherent to the skin, but its fibres rapidly converge as they pass in the direction of the shoulder-joint, opposite which region they gradually free themselves from the skin to form a small fusiform muscle, which, ending in a delicate tendon, runs along within the free marginal fold of the patagium of the wing, in common with the tendon of the *tensor patagii longus*, to blend with it just before reaching the carpal joint.

I propose to call this muscle the *dermo-tensor patagii*, it being partially connected with the integumentary system of muscles in the birds in which I have thus far found it.

Searching for it in all the other American Swallows, I find it to be about equally well developed in every species, and absent in none of them.

This muscle surely does not correspond with the "bicipital slip of the patagium," as described by Garrod, and dwelt upon as the *tensor patagii accessorius* by Professor T. Jeffery Parker in his 'Zootomy' (1884, p. 251) as occurring in the Common Pigeon, for it makes no connection whatever with the biceps muscle.

Being desirous at this point of determining its presence or absence in a few other groups of birds, I stepped aside for the moment, and first examined a number of Passerine types, including very diverse forms,—it was present in all of them. Next, with the Caprimulgi, Trochili, and Cypseli, I found it completely absent, as it was also in a specimen of *Tyrannus tyrannus*, kindly sent me by Mr. H. K. Coale of Chicago, from which I am led to infer that it does not occur in the mesomyodian Passeres. Further than this I did not pursue the subject, but left it for subsequent investigation and the researches of others interested in such matters *.

Of the Pectoral Muscles.

Every species of American Swallow has been dissected by me to ascertain the character and number of these important

* Further opportunities for examining the literature of this subject now enable me to state that the muscle here described is the "*pars propatagialis musculi cucullaris*" of Fürbringer and Gadow; and it has been carefully considered by me in an extensive work upon the muscles of birds now in the hands of the Smithsonian Institution for publication.—R. W. S.

chest-muscles as they occur in the group. In every individual instance I found the state of affairs essentially the same, and the Swallows agree with all true Passerine birds which I have thus far examined, in possessing all three of the pectoral muscles. The *pectoralis tertius* is, comparatively speaking, very large, and arises nearly or quite as far back on the anterior aspect of the sternum as the *pectoralis secundus* does; it also arises, as is usual, from the outer side of the shaft of the coracoid bone of the shoulder-girdle. *Pectoralis major* makes a very broad and strong tendinous insertion at the ordinary site upon the shaft of the humerus, while the tendon of the second pectoral passes through the usual canal formed by the juxtaposition of the bones of the shoulder-girdle. In texture the fibres of the great pectoral in Swallows seem to be always coarse and of considerable size.

To these characteristics with respect to the pectoral muscles as I found them in the smaller representatives of the group, *Progne subis* forms no exception.

Of the Muscles of the Thigh.

According to Garrod all Passerine birds exhibit, for the classificatory group of muscles of the thigh, the myological formula A. X. Y (except *Dicrurus*, wherein it is A. X); *i. e.*, they possess the femoro-caudal, the semitendinosus, and the accessory semitendinosus—the accessory femoro-caudal and ambiens being absent. Upon carefully examining the Swallows, I find that this is also the rule with them; and these muscles seem to be about equally well developed in the several genera, although it struck me that the accessory semitendinosus was, comparatively speaking, rather feebly developed in *Progne*. Beyond these special muscles, I did not investigate the myology of the pelvic limb of these birds.

Notes on the Arterial System.

Swallows, in common with other *Passeres*, also have but one carotid artery, the left, which courses up the neck, as usual, in the hypapophysial channel at the mid-anterior aspect of the cervical vertebræ. And in the pelvic limb the main artery I found to be the *sciatic*, which is likewise the rule among the Passerine birds, and Professor Garrod found but few exceptions to this.

On the Trachea, Visceral Anatomy, and other parts.

More for my own satisfaction than with the expectation of revealing any structure that would prove to be different from what we already know of the morphology of the trachea or other parts in the Passerine birds, I examined the wind-pipe, its muscular and associate parts, as I did the several organs in the chest and abdomen of these American Swallows, but found nothing that required to be specially noted here.

The trachea exists as we find it in most true Passeres, as do the several pairs of muscles at its lower larynx. I found the "sterno-tracheales" to be very delicately formed indeed, almost of hair-like proportions in some of the genera, as in *Progne.*

The gall-bladder is of good size, and the right lobe of the liver the larger division of that organ.

Cæca coli are present in Swallows, but are of almost rudimentary proportions, and in some cases might be easily overlooked.

It is my intention to refer to a few of these points again, when we come to consider the visceral anatomy of the Swifts and Humming-birds.

The Osteology of the Hirundinidæ.

Skeletons of representatives of all the *Hirundinidæ* of the United States are before me, and in sufficient number, so that a general definition for this part of the structure of these birds becomes quite possible, and will be given here. It is my intention, however, to be brief in this matter, not only on account of space, but in view of the information already given.

Of the Skull.—When I came to compare and examine the skulls of our seven species of Swallows, I was surprised to find them presenting such striking differences in their general form. Not but that they could each and every one of them be recognized at once as skulls of Swallows, but rather that they possess characters quite distinct and peculiar to the species, and there would be no difficulty whatever in telling, for instance, the skull of a Barn-Swallow from one of a Cliff-Swallow—so diverse is the general outline of each.

In *Progne subis* (Pl. XXI. figs. 18, 19, and 20) we find a skull that exemplifies all the characteristics which pertain to the Hirundine skull generally.

Its superior osseous mandible is very broad at the base, but promptly tapers to a sharp and somewhat depressed tip anteriorly, while all this portion of the skull is much compressed in the vertical direction. The form of the external narial apertures can best be appreciated upon a superior aspect, and are seen to be long, elliptical openings placed longitudinally. Through either one of them we may discern the upper surface of the anterior part of the palatine of the corresponding side. The lateral free edges of this mandible are sharp and turned downwards, while the maxillary on either side is a horizontal plate fully three times as broad as the slender jugal bar that continues this infraorbital rod to the quadrate. We find no projecting processes from the lateral margins of any part of this osseous superior mandible as have been erroneously figured for the skull of *Progne* by other anatomists (‘Science,’ N. Y., No. 223, fig. 3). Just anterior to the frontals, and posterior to the external narial apertures, there exists a subtriangular area of bone on the top of the mandible, which is formed by the proximal portion of the premaxillary and the nasal bone on either side. In the adult skull, of course, the *sutural* boundaries of these bones have been absorbed, but by holding the skull up to the light the proximal end of the premaxillary, and what was the median margin of a nasal, and finally the anterior limit of the corresponding frontal bone can all be easily distinguished, while the small triangular space they circumscribe, is also of bone, but considerably thinner than the other parts mentioned. In all Swifts that I have examined this thinner portion on either side has become absorbed, and a little triangular opening is found at the site instead. My explanation will be made quite clear by turning to Plate XXI., and comparing figures 22 and 23; in figure 23 at x is shown the thinned portion, while in the Swift's skull, figure 22, an opening actually takes its place on either side. Of course, in a skull so vastly different from the Cypseline skull as the Humming-bird's is, no such comparison as this is necessary.

For the rest of the superior aspect of the skull in *Progne* we find the frontal region narrow between the orbital margins, the posterior edges of which latter are sharp, thin, and somewhat tilted upwards. The parietal region is smooth and rounded, while a shallow, mid-longitudinal gutter traverses this part of the skull (fig. 19).

Regarding this part of the skeleton of the Purple Martin upon a lateral aspect (fig. 18), we are to note the form and comparatively large size of the pars plana (*p.p.*), the slender and rather small pterygoids, as well as the fact that the osseous interorbital septum is pierced by two large vacuities of a form in most specimens shown in the drawing. This figure displays so well the characteristics of the lateral part of the cranium proper in *Progne*, that any further account becomes superfluous.

Turning to the base of this skull (fig. 20), we are to note the form of the vomer and the maxillo-palatines; the first has very much the character of that bone as we usually find it in the Passeres. The maxillo-palatines have their median free extremities dilated, and they, as in all Swallows, are separated by several millimetres in the middle line.

The palatines articulate with each other for the posterior two thirds of their length beneath the sphenoidal rostrum, and are in close contact at their pterygoidal heads, as in the pterygoids themselves in this latter locality.

As in all Cypseline birds which I have examined, the posterior external angles of the palatines in *Progne* are somewhat drawn out, and then squarely truncated (compare figs. 19 and 22, *pl*). Swallows have the occipital condyle very small, while the foramen magnum is relatively large, and its plane makes an angle with the basi-cranial plane of some eight or ten degrees.

Posteriorly, the skull in *Progne* exhibits a large supra-occipital eminence, and an occipital area which is nearly circumscribed by a sharply defined occipital ridge or line, which defines its form as reniform, and placed transversely at this aspect of the cranium.

Coming next to the *mandible* of this bird, we find it to be of a V-shaped outline, with its ramal sides shallow in the vertical direction, and with a symphysis of some depth anteriorly at its apex. There is a swell, on either side, at the superior ramal margins at points about where the horny theca ceases and the skin commences, when these latter parts are *in situ*. A small slit-like ramal vacuity exists, and the posterior angular processes are well-developed, though they curve up but very slightly.

Essentially, the hyoidean apparatus is Passerine in character;

I find, however, that the basibranchials are anchylosed into one piece, while the glosso-hyal and the cerato-hyals are apparently not ossified even in the adult Martin.

Several skeletons of *Petrochelidon lunifrons* have been carefully prepared by me from specimens of the bird which I collected a year ago at Fort Wingate, New Mexico, and they are now at hand. So far as the skull and hyoidean apparatus of this Swallow are concerned, we might almost cover the ground of our description by saying that in these parts the bird is the veriest miniature of *Progne*; and, indeed, so true is this, that any detailed description is rendered quite unnecessary.

Two points it will be well to note, however, for I believe, comparatively speaking, the cranial capacity in *Petrochelidon* is relatively larger than it is in *Progne*; and although the palatines are very much of the same shape, the postero-external angles in the former are more inclined to be rounded than truncated as they are in *Progne*.

Chelidon erythrogaster in this part of its skeleton probably typifies the Hirundine skull (Pl. XXI. figs. 21, 23).

In it the superior osseous mandible is very broad at its base, and the postero-external angles of the maxillaries have a tendency to project a little. The frontal region is more than usually narrow between the upper margins of the orbits. Laterally, we note that the vacuities in the interorbital septum are usually larger than in other Swallows, though yet but two in number, and of the same general outline. One thing characteristic of the skull of *Chelidon* is its uncommonly minute occipital condyle; I cannot recall at this moment any bird of the size of this Swallow which possesses this feature in anything like such diminutive proportions. Its pterygoids and the quadrato-jugal bars are also wonderfully slender osseous rods.

Agreeing almost exactly with the mandible in *Progne*, save in size, this bone in our Barn-Swallow requires no special mention. In the hyoidean arches, however, it would seem that ossification is regularly extended to the glosso-hyal and the cerato-hyals, which was not the case, as we will remember, in the Martin.

Passing to the genus *Tachycineta*, we meet with a skull, in either species representing it (*T. bicolor*, *T. thalassina*), which, although essentially Hirundine in all particulars, yet bears a closer resemblance to some of our other Oscines, not Swallows, than any of the other skulls of the *Hirundinidæ*. This is principally due to the fact that in the skull of *Tachycineta* the base of the osseous superior mandible is not nearly so broad in comparison as it is among the other Swallows, and consequently more nearly approaches in appearance the skull of some of those Passeres which possess mandibles with rather broad bases.

The structural details seen at the base of the skull in *Tachycineta thalassina* I have already shown in a previous memoir, wherein I have figured those parts in a specimen of that Swallow (P. Z. S. 1885, p. 899, fig. F); and as that figure is readily accessible to the reader, a comparison of it with the figures in the present paper may be made without difficulty.

Nothing worthy of special record is to be found in the *mandible*, nor in the *hyoid arches* of the skulls or the latter apparatus in the genus *Tachycineta*; they present all the true characteristics of those parts as already described above with sufficient fulness for the *Hirundinidæ* generally, and our present purpose.

What I have just said of the skulls and associated parts as found in the two species of the genus *Tachycineta* applies with equal truth to the corresponding structures as found in *Clivicola riparia* and in *Stelgidopteryx serripennis*, of which I have several examples of each before me.

In their general form they, too, remind us more of the skulls of certain other types of Oscines than do the skulls of the other Swallows which were described above, previous to our taking up the skulls of the genus *Tachycineta*.

Of the remainder of the Axial Skeleton in the Hirundinidæ.—My labour is considerably lightened here from the fact that I have already touched with some degree of fulness upon the axial skeleton of *Tachycineta* in my first memoir in the 'Proceedings of the Zoological Society' (1885, p. 906); and then, again, the sternum and shoulder-girdle of the Swallows is very well known, making any detailed account of it here unnecessary.

By those who have read it, it may be remembered that I found 35 vertebræ and a pygostyle in the spinal column of a Swift (*Micropus*), and the same number of segments in the column of a Swallow (*Tachycineta*). Upon careful examination I am now enabled to state that this is the normal number for all our Swallows, and I have yet to find an exception to it. Should such an exception be found, I predict it will simply be a free, and perhaps rudimentary, vertebra at the end of the series of the caudal segments.

Further, I find the arrangement of the free vertebral ribs and their uncinate processes the same for all Hirundinidæ, as I found them to exist in the Violet-green Swallow in my former memoir. This arrangement consists in their having 12 cervical vertebræ that do not possess free ribs; the thirteenth has a rudimentary pair; the fourteenth has them better developed, and even may have uncinate processes upon them; the fifteenth are the first to connect by costal ribs with the sternum, as do the ribs from the sixteenth to the nineteenth vertebræ inclusive. The twentieth is the first vertebra appropriated by the pelvis, and this latter compound bone monopolizes ten of these segments, so that the first free caudal is the thirtieth vertebra of the spinal column.

Thus far at least one Swift (*Micropus*) was found by me to exhibit an arrangement similar to this, and later on we may look into the matter for *Chætura*.

The Humming-birds possess, as I have elsewhere stated, but 32 vertebræ and a pygostyle in their spinal column.

Every species of our Swallows possesses a *pelvis* of a pattern characteristically its own, so that had we before us a dozen pelves of *Progne*, a dozen of *Chelidon*, and a dozen of each of the others we should have no difficulty, after once becoming acquainted with them, in picking out the several varieties correctly. Then, again, these pelves all strictly fall within the general description applied to what we please to call *a Passerine pelvis*, so far as our present knowledge and ideas of such a bone can be formulated. Now there is nothing that I can at this moment place my finger upon in the pelvis of a Swift that debars it from being classed in the same category; and indeed, when we come to examine into the matter closely, the differences between the pelves of *Micropus* and *Progne* are no greater than are the differences between the pelves of *Progne* and *Chelidon*.

Ornithologists have long ago placed on record descriptions of the *shoulder-girdle* and *sternum* of Hirundine birds, and the morphology of these parts in them is so well-known that to say, that although each species of Swallow has a characteristic form of sternum and shoulder-girdle of its own, these elements of the skeleton in all of them are strictly Passerine,—will sufficiently meet our aims in the present connection.

In my memoir in the P. Z. S. already referred to I made comparisons of these parts as they occur in *Micropus* and *Tachycineta*, and further on, when we come to examine the skeleton of *Chætura*, a few more words on the subject may be added.

Of the Skeleton of the Limbs in Swallows.—All of the Hirundinidæ agree with the true Passeres in having the little ossicle known as the *os humero-scapulare* at the shoulder-joint, but I have failed to find it in the Cypseline birds.

In the Proc. Zool. Soc. for April 1887 I figured the *humerus* of *Tachycineta thalassina*, and further on in this article I shall have to refer to that drawing. Now, so far as the humeri of the other Swallows are concerned, they all more or less resemble the bone as found in *Tachycineta*: they are invariably non-pneumatic, proportionately short in the shaft as compared with the size of the bird, and quite so relatively when taken in comparison with the Passeres generally. Especially in *Chelidon* is this brevity of the humeral shaft noticeable; and it becomes of interest to know that in a specimen of this Swallow I find a humerus 15 millim. long to an ulna 24 millim. long, and in *Progne* a humerus 22 millim. long to an ulna of 33 millim., while in a Swift (*Micropus*) we have a humerus 11 millim. long to an ulna of but 16 millim. in length, showing a difference of 9, 11, and 5 millimetres respectively.

Swallows have at least one good-sized sesamoid at the elbow, but I thus far have failed to detect any such small bone in a Swift; in *Micropus*, however, I find in the same tendon a small nodule of dense cartilage.

The shafts of both ulna and radius are noticeably straight for nearly their entire lengths, and in their general conformation depart but little from the usual form assumed by these bones in the Passeres at large.

I have already pointed out elsewhere that n a Swift (*Micropus*) these bones are also markedly straight, and are, comparatively speaking, almost as short for a bird of its size as is the humerus,—Swifts, as a rule, deriving their length of wing from the long bones of the pinion, and not from those of the brachium and antibrachium.

Radial and ulnar ossicles are found in the carpus of all Hirundine birds, as usual, and in their form and method of articulation no departure whatever is made from the composition of the wrist-joint, as seen in all others of the group.

There are no claws on the finger-end in the manus and phalanges, and the carpo-metacarpal bone is much of the same shape as we find it in Passeres generally.

To one point I desire to direct special attention, and that is—that in all Swallows in their carpo-metacarpal bone the metacarpal which belongs to the index digit is considerably *shorter* than the one which belongs to the annularis digit of this compound bone. This arrangement is strikingly apparent in such a bird as *Progne subis*, and it will be remembered that in *Trochilus* this is also the case, though not so marked; whereas in Swifts the reverse condition obtains, and the metacarpal of the index digit is rather the longer of the two.

Little need be said here in regard to the osteology of the pelvic limb of the Swallows, for from femur to phalanges it is characteristically Passerine, and in every species the relative lengths of the several long bones composing it are harmoniously proportioned. Be it noted, however, that Swallows always possess a *patella*, and that in them the pro- and ectocnemial processes of the tibia are always well developed, while the *fibula*, although often of only hair-like proportions (*Progne*), descends below the middle point of the shaft of the tibio-tarsus.

Further, in the hypotarsial process of the tarso-metatarsus there are four perforations for the passage of tendons, these openings being arranged as though they were at the angles of a square, one pair being next to the head of the bone, and the remaining pair immediately behind them.

When I come to review, further on, the characters of the pectoral and pelvic limbs of certain Swifts and Humming-birds, it will be necessary to revert again to some of these Hirundine characters as found in their limbs; and so it will not be necessary to enter more fully into details at this point, but rather reserve them for the more effective work of actual comparison.

On the Morphology of certain Cypseli and Trochili.

Of the External Form and Pterylography of certain Cypseline and Trochiline birds.

Very good hints sometimes as to a bird's affinities may be gathered from a study of its general contour and form after it has been carefully plucked for the purpose. With this in view, and in this way, I prepared specimens of *Micropus melanoleucus*, *Chætura pelagica*, and *Trochilus platycercus*, and present drawings of the same here to illustrate my meaning. A glance at the contour of *Micropus* will be sufficient to convince us that in general outline it is strikingly, indeed actually, far more like any one of our Swallows, as *Progne* for instance. And, apart from the resemblance which its short antibrachium gives it to *Trochilus* (Pl. XXIV. fig. 39), it has no other character upon this aspect of its body to support the view that any true relationship exists between it and the latter bird. For the rest, to my mind, shortness of the antibrachium amounts to nothing as an indication of affinity unless correlated with actual similarity of form in its details. *Chætura* having a deeper carina to its sternum than has the other Swift, *Micropus*, it bears a somewhat more general resemblance to the body of a Humming-bird (fig. 39) than it otherwise would do, or as does *Micropus*; but some of the smaller Petrels might hold an equal claim to affinity with *Trochilus* were it based upon such data as this.

Coming to a few of the true characters, we find the bill, the position of the commissure of the gape, the feet, and some other points widely different in a Swift from what the corresponding characters are in a Humming-bird; and when *Micropus* is the Swift chosen for the comparison, the *entire contour of its body* differs from that of *Trochilus* in all important particulars.

Let us next examine the pterylography of these three birds, and see what it indicates in regard to their affinity.

Nitzsch has presented us with fairly good figures of the pterylography of *Cypselus apus* and *Trochilus moschitus* (Pterylog., ed. Sclater, pl. iii. figs. 16–19); but there are several points requiring elaboration in his account, while in other particulars his comparisons are deficient.

Taking his figures and descriptions just as they stand, however, and bringing into the discussion his figure 14 on the same plate, of *Hirundo urbica*, we find that the pteryloses of the Swift and Swallow, so far as their heads are concerned, agree, with the exception that the Swift possesses those peculiar crescent-shaped apteria, one over each eye; these are absent both in the Swallow and Humming-bird.

But the Humming-birds have a median naked space of a spindle-shaped outline on the crown, situated longitudinally, and between the eyes and the base of the superior mandible. This is well marked in all species which I have thus far examined, and it was overlooked by Nitzsch; moreover, it is absent in the Swifts and Swallows.

On the throat of Swifts and Swallows the feathering covers the entire area, while in Humming-birds the median naked space of the neck is continued almost up to the base of the inferior mandible.

Again, Nitzsch noticed the naked "nape-space [see his figure] beneath the long cornua of the hyoid bone," but "could not determine with precision" whether or no it was a constant character for the pterylography in the *Trochili*. My investigations convince me that it is a constant character in them, and, further, that it is *never* present in the Swifts nor Swallows. If any one will take the trouble to pluck a Humming-bird and note, in the natural position of its head, that the back of the head comes very close to the body, he will see at once how this naked space has come to be present there.

The arrangement of the pterylæ upon the ventral aspects of all of these birds is more or less alike, being apparent modifications of some Passerine type; but not so with the spaces upon the dorsal aspects, for here we find that the true differences among them come in (compare Nitzsch's figures). And we must remember that Nitzsch, in speaking of the pterylography of the Macrochires, was forced to admit that:—"In this family I place the two genera *Cypselus* and *Trochilus*, which, indeed, present but little external similarity, but are very nearly allied in the structure of their wings" (p. 86). To the near alliance on account of the latter character we will revert later on.

In the first part of this memoir I have attempted to point out such differences as exist between the pterylography of a Swift and a Swallow, so it will not be necessary to enter so fully upon the details again here. Be it borne in mind, however, that, upon this dorsal aspect of the two, in both the *humeral tract* crosses obliquely *at a point opposite the middle of the humerus of the arm*; in *Trochilus*, on the other hand, *it is over the head of the humerus*. Swifts and Swallows both possess a femoral tract; whereas it is absent as a rule (and, for all that I know to the contrary, always) in the Humming-birds—certainly so in *Trochilus*.

In Swifts the "spinal tract" connects the capital area behind with the oil-gland, but just opposite the shoulder-joints bifurcates; the bifurcations are as wide as the original tract, and after passing the middle of the back they converge again, and unite at a point over the anterior end of the sacrum. Thus we find a spindle-formed figure produced, which is characteristic of the Cypseli.

In Swallows the bifurcation does not take place until the spinal tract arrives nearly at the middle of the back, and then the ends of the fork fail to join the rump-tract below.

Now in Humming-birds, and I have examined a great many excellent specimens of them, the "spinal tract" is altogether different from this, for it consists of a very broad, lozenge-shaped figure, spreading out over nearly the entire dorsal region, being prolonged in a wide nuchal strip which merges with the "capital area" anteriorly, while its lower angle rests upon the uropygial gland, and laterally spreads over the femoral region. Mesially, and in the middle of this lozenge-shaped area, we have a short longitudinal naked strip, but not nearly so conspicuous as it is in the Swifts.

Indeed, the pterylography of a true *Cypselus* and *Trochilus* is as different in character as any two forms of birds can well be in this particular; and if one, unprejudiced in mind, will look at plate iii. of Nitzsch's work, there will be seen a greater similarity between the dorsal tracts of *Cypselus apus* and *Coracina cephaloptera* than between *Cypselus apus* and *Trochilus moschitus*.

We are already aware that, notwithstanding Swifts and Humming-birds possess the same number of primaries and rectrices, it rather conveys the impression that this is more a matter of chance, when we find that they essentially *differ in their pterylography* and in the *number of secondaries in their wings*.

For another external character in the Swifts, and a very excellent one, which I have failed to find elsewhere described, we must turn to the integuments covering the pinion. Here we find the entire skin exclusive of the border surrounding this part of the limb, and on both sides, *of a deep black colour*, being produced by a pigmentary deposit in the skin itself. This peculiar character is present both in *Micropus* and *Chætura*, while it is entirely absent in *Trochilus*. Swallows also lack this pigmentary deposit in the skin on both surfaces of the pinion.

To conclude this chapter, then, I will make a few comparisons between the external forms and characters of *Micropus*—a true Swift—and *Trochilus platycercus*—a typical Humming-bird.

So far as the general form of these two birds is concerned, a glance at Pl. XXIV. figs. 37 and 39, will be sufficient to convince any one that they are *as different as they can well be.*

In the character of *their beaks* they are as widely different as any two types in the entire class Aves.

They differ essentially in *their pteryloses,* and in the number of the secondaries.

Their feet are *radically* different, quite as different, for instance, as are the feet of a Swift and a Sparrow-Hawk.

The majority of these differences in these two types are absolutely of an ordinal rank (for Aves).

And now, before entering upon their internal structure, let me add here the well-known fact that these birds also *differ essentially in their habits, their mode of nidification, and the manner of securing their food*; indeed, in all these particulars in their life history they are widely, very widely different.

A critical Comparison of the Pectoral Limbs of certain Cypseli *and* Trochili.

From time immemorial in Ornithology the two main characters upon which systematists have relied for retaining the *Cypseli* and *Trochili* in the same group of birds, as related forms, are the supposed similarity of the structure of their wings, and the fact that both possess an unnotched sternum. Finding that these birds widely disagree in so many vital, fundamental particulars, it is my object to compare them very critically with respect to their wing-structure, and the present section will be devoted to the results of my investigations in that direction. Swallows, as we know, possess a wing-structure very similar in organization to the Passeres generally, so it will not be necessary to make many comparisons with them in the same connection. We have just seen how essentially different the wing of *Trochilus* is from the wing of *Micropus,* so far as its external characters are concerned: to be sure they have a superficial resemblance, as both have short humeri and long pinions, but this resemblance gives way when we come to compare the parts in detail.

First, then, let us examine the method of attachment of the patagial muscles, surely a character which has proved itself to be a useful one, and one eminently connected with the wing-structure in birds, be they Swifts or Humming-birds. Now Prof. Garrod dissected a Humming-bird with the view of ascertaining the point which concerns us here, and he had a specimen of *Patagona gigas* for investigation. Moreover he made a drawing of his dissection of the parts in question, and it may be seen in figure 1, plate xxiv. of his 'Collected Scientific Memoirs.'

With the exception of leaving off the lower *extensor* of the forearm, his drawing is correct, and from it we see that the *tensor patagii longus* arises and is inserted pretty much as we find it in most birds; but with respect to the *tensor patagii brevis* a very marked departure is met with, for that muscle is as prominent as any other in the arm, more so than the majority of them. It may be said to be somewhat pear-shaped in form, with its larger end at the origin at the shoulder, while the smaller extremity becomes attached to a tendon which passes directly over the upper surface of the *extensor metacarpi radialis longior*, longitudinally.

This tendon arises at the outer condyle of the humerus, and passes to the carpus for insertion, and is very well shown in Garrod's drawing of *Patagona.*

I find it present in all the *Trochili*, where, so far as I know, it constitutes a unique method of insertion for the *tensor patagii brevis*, and to make it clearer I present a drawing of it for *Trochilus platycercus* (Pl. XXII. fig. 28).

Since Garrod saw so clearly this very unusual insertion of the *tensor patagii brevis* in the Humming-birds, I am surprised beyond measure that he did not at once make *careful* comparisons with the Cypseli in this particular; had he done so, he would have found, as I have, that the mode of insertion of this muscle in those birds is *entirely different.* In the first place the body of the muscle is comparatively much smaller; it is also of a very different form, being oblong and not pear-shaped; finally it *is not inserted into any special tendon*, but directly upon a tendinous fascia on the surface of the *extensor metacarpi radialis longior*, and its fibres, becoming slightly tendinous, run down with that muscle for insertion at the external condyle of the humerus. In Pl. XXII. fig. 29, I present a drawing made directly from my dissection of these parts in a specimen of *Chætura pelagica.*

As both the Humming-birds and Swifts have short humeri (though "shortness" is not a character, I believe) and have developed a large *tensor patagii brevis* (though "size" is not a character either, I believe) it might not unnaturally be expected that they should have this particular muscle *short and thick*; but when we come to examine the true morphology, how vastly different is it! Quite as different, we may say in truth, as are the humeri of these birds.

The *tensor patagii longus* in *Chætura pelagica* has the usual origin and insertion that it has in so many of the Class.

Cypseli and Trochili both possess all three *pectoral muscles*, but in such a form as *Micropus* they are none of them unduly developed; better so in *Chætura*; while in the Trochili they are, comparatively speaking, enormously developed.

Owing to the entirely different shape of the humerus in Swifts and Humming-birds, the tendons of the pectorals make dissimilar insertions. For instance, the *pectoralis major* in *Micropus* is inserted upon the entire palmar aspect of the large hook-like radial crest of the humerus of that Swift; but *Trochilus* possessing no such process upon its humerus, the muscle is obliged to insert itself more or less upon the body of the bone, at a point which would be considered as the base, upon the palmar side of a radial process did such a thing exist there.

Now the *pectoralis secundus* in *Micropus* is inserted at the head of the humerus upon its anconal side, between the summit and radial crest or hook; while in the Humming-bird this second pectoral sends its tendon *across* the head of the bone, to be inserted at the distal margin of the pneumatic fossa. The insertion of the *third pectoral* in these two groups of birds is more similar.

So here, again, we see that Swifts and Humming-birds are markedly different with respect to another class of muscles which make up, in part, the fundamental organization of their wing-structures.

Among the essential characters of the wing we still have left the skeleton, but I have already published my views and drawings in regard to that part of their economy elsewhere (Proc. Zool. Soc. 1885 and 1887). I have there shown conclusively that the humeri of Swifts and Humming-birds are very differently formed bones indeed, and the reader has but to refer to the figures in the papers to which I allude to be convinced upon this point.

As I have elsewhere stated, the humerus in *Micropus* is a non-pneumatic bone as in the Swallows; while all Humming-birds, so far as I have examined, have pneumatic humeri. Still my statement Proc. (Zool. Soc. 1887, p. 503) requires some modification, for since that was written I have found that the humeri in *Chætura pelagica* are pneumatic, but the bone is shaped upon the same plan as the humerus of *Micropus*, and the *pneumatic fossa is*, as in Passeres, *on the ulnar side.* From what has gone before, we now know that in *general form*, and other particulars, *Micropus* is nearer the Swallows than is such a Swift as *Chætura*, and this last fact, with respect to the arm-bones, points still more strongly to the truth of such a statement. Even at this moment I am not acquainted with any other bird in the Class that has the pneumatic fossa of its humerus situated on the radial side of the bone, as the Trochili have. This fact alone, and surely when taken in connection with the otherwise vastly different form of the bone itself, is sufficient to show that in their wing-structure Swifts and Humming-birds widely differ.

Further, in the papers above alluded to I have already pointed out how in the bones of the antibrachium, in *Trochilus* and *Micropus*, the radius is actually bent to a bow in the former, while it is as absolutely straight as any bone can be in the Swift. The ulna, too, in these birds differs in its general form. Moreover, we find sesamoids present in the carpus of Humming-birds which do not exist in Cypseli, although, since writing my first memoir on this subject, I have found a sesamoid at the elbow in *Chætura* and *Micropus*, such as the Swallows have.

Coming next to the carpo-metacarpus we find one great and principal difference, in addition to minor ones—in the Humming-birds the middle metacarpal in this compound bone is *longer* than the index metacarpal, the reverse condition obtaining among the Swifts. This is enough to show that the bones are essentially unlike in their most important character. The proximal phalanx of the index finger is altogether a differently formed bone from the corresponding segment in the manus of the Swift, as any one may see by a comparison either of the bones themselves or my drawings (P. Z. S. 1885, pl. lxi. figs. 3 and 4, *j*).

To briefly recapitulate, then, the absolutely essential and fundamental characters in the wing-structure of a Swift and a Humming-bird, I find that :—1. The parts markedly differ in their external characters, inasmuch as they do not possess the same number of secondary quill-feathers ; Swifts have a very peculiar pigmented (deep black) area of the skin centrally located on both sides of the hand, while Trochili have not ; the character of the plumage is quite different; and the *position of the "humeral tract" in the pterylosis* is different, being across the middle of the humerus in Swifts, and overlying the head of the bone in Humming-birds. 2. The mode of insertion of the *patagial muscles*, as well as the *form* and *character* of these muscles themselves, is altogether different in the two groups. 3. The method of insertion of the *pectoral muscles* is essentially different. 4. Throughout the entire skeleton of this limb, the individual bones in Swifts and Humming-birds differ widely in characters of the very highest import, both morphologically and in the position, absence, and presence of parts.

All this being so, I am firmly convinced that were the minor details in structure in these two wings carefully worked out under the lens of a good microscope, they too, of necessity, would also be found to be at variance. Indeed, in making my own dissections of the Trochili under a 2-inch objective I saw quite enough to fully confirm this suspicion.

Finally, I must say, as I have already remarked in a previous paragraph, that heretofore too much stress has been laid upon the fact that both Cypseli and Trochili possess *short humeri*; and, further, to my mind, *shortness*, *per se*, does not constitute a valid character, for if it did, some very remarkable forms would surely be grouped together! My painstaking labours upon the wing-structure of Swifts and Humming-birds convince me fully that, in so far as this part of their organization is concerned, there is little or no affinity at all.

Notes on the Anatomy of the Pelvic Limb in certain Cypseli *and* Trochili.

Having shown how innately different the wing-structure in Swifts and Humming-birds really is, let us now take a look at their pelvic limbs.

It will not be necessary to pass the external characters of these parts in review, as they are already well known; it will be sufficient to remark that the pelvic limb of such a bird as *Micropus* differs from the pelvic limb of a *Trochilus* in all its more essential external characters.

My investigations tend to confirm the statement of Professor Garrod, that Humming-birds and the American Swifts *Chætura pelagica* and *Micropus* lack the accessory femoro-caudal, the semitendinosus, and the accessory semitendinosus muscles from the group at the thigh; in other words, their formula is A.

This from a physiological point of view would naturally be looked for, as no members of these groups use their limbs for locomotory purposes; and consequently these special muscles have long since been missing, or perhaps in neither of them have they ever been present. But to this matter I shall refer further on.

Coming next to the *plantar tendons*, I find the arrangement in the Swifts at hand the same as described by Garrod for *Cypselus alpinus* (Coll. Scient. Mem. p. 294), and as that has already been made clear to us, I need not quote it here; but after having carefully prepared the foot of a specimen of *Trochilus platycercus*, and bringing the limb under the lens of a powerful objective, which increased the size of this Humming-bird's foot to that of a Crow, I was enabled at once to discover that the arrangement of the plantar tendons in these birds is very different from what obtains in the Cypseli; in other words, in *Trochilus* these tendons are disposed very much as we find them in the Passeres, where the tendon of the *flexor longus hallucis* is distinct from that of the *flexor perforans digitorum*. It is just possible that in Humming-birds a slight vinculum may connect the two, and although I could not quite satisfactorily demonstrate this minor point, yet I am inclined to think that such a vinculum is present.

I found the *sciatic artery* the main artery of the leg in both Cypseli and Trochili, but that is the usual arrangement for nearly all birds, which weakens its importance as a distinctive character.

As to the skeleton of this limb in these birds I have already contributed some work (P. Z. S. 1885, pp. 909–913), and little or nothing need be added here. Suffice it to say that morphologically the constitution of the pelvic limb, so far as its skeleton is concerned, is radically different in Cypseli and Trochili. A few points will be sufficient to convince any one of this fact, for in *Trochilus*, for instance, we have a large *patella* present, a bone *entirely missing* in *Micropus*; in *Trochilus* we have the hypotarsial process of the tarso-metatarsus *both pierced* and *grooved* for the passage of the tendons, whereas in *Micropus* it simply exhibits *one deep groove* for that purpose; finally, the foot in each case is widely different, for in *Trochilus* the joints of pes stand 2, 3, 4, 5, while, as we know, in *Micropus* they stand 2, 3, 3, 3.

As existing birds are classified, and were two such forms as *Micropus* and *Trochilus* classified upon the characters presented in their pelvic limbs alone, all I can say is, that to my mind there should be no hesitation whatever in placing them in widely separated groups, notwithstanding the fact that the myological formula of the thigh-muscles is the same. For even when we come to examine these very muscles closely we soon discover that they are quite *differently formed and disposed*, which should also be taken into consideration in face of the fact of the mere presence or absence of parts.

For the rest, the limb in these two groups of birds to its very toe-joints is about as essentially different as are the limbs of an Ostrich and a Coot.

On the Anatomy of the Head.

Were I asked to pick out any two forms of existing birds from any part of the world which present us with the greatest number of fundamental differences so far as the anatomy of the head is concerned, it would puzzle me, I think, to select two more diverse types than a true Swift and a Humming-bird. Indeed, from tip of beak to nape it is difficult to find comparable characters that show any affinity of the forms in question at all. I have already pointed out above the very evident differences that are exhibited upon a comparison of the external characters of such a Swift as *Micropus* and any of the Trochili; while the principal differences in the skulls of these birds have been already dwelt upon *. And has the day yet arrived when differences of the most manifest character in the skulls of birds are to be ignored in taxonomy, and set aside as of no value?

At the present time I have before me upwards of a hundred anatomical specimens of Trochili and a great many Swifts; but for a brief *résumé* of some of the distinctive cranial characters let us choose a specimen each of *Chætura pelagica* and *Trochilus rufus*, and see how they compare in these two types. We find these characters to be as follow:—

* Proc. Zool. Soc. 1885.

Chætura.	*Trochilus.*
1. Superior mandible wide and not produced.	1. Superior mandible narrow and usually twice as long as the head.
2. Triangular openings between nasals and frontals, divided by the premaxillary.	2. No such openings present.
3. Cranium above smooth and rounded.	3. Cranium above showing a deep, longitudinal groove for ends of hyoid.
4. Vomer truncated.	4. Vomer long and spine-like.
5. Maxillo-palatines prominent and produced well backwards, tending to approach mesially.	5. Maxillo-palatines not prominent, rounded, and wide apart.
6. Postero-external angles of palatines produced as prominent processes.	6. External margin of each palatine nearly straight, and no *angle* present.
7. Palatine heads of pterygoids nearly meet mesially.	7. Palatine heads of pterygoids widely separated mesially (and I have seen specimens where they *anchylosed* to the palatines).
8. Pars plana small and formed as in Swallows.	8. Pars plana very large, and very different from the Swallows.
9. Interorbital septum shows several vacuities, and these are distinct from those on the posterior orbital wall.	9. Interorbital septum never shows but one vacuity, which merges with one that absorbs nearly all the posterior orbital wall.
10. Mandible a wide V, without ramal vacuity.	10. Mandible a long and extremely narrow V, with ramal vacuity.

In short, these skulls evidently belong to very different Orders of birds, and their differences upon a lateral view can be well appreciated by examining and comparing figures 24 and 27 of Plate XXII.; the Swift there figured, however, is *Micropus*, but will answer just as well.

Carefully comparing *the brain* in several specimens of Humming-birds of different species, with the brains of Swifts and Swallows, I find that, although in all three groups the brain and its parts are strictly fashioned upon the true avian plan, in the Swifts and Swallows its general and special form is far more alike than it is when we compare it with the brain in a *Trochilus*. This we might naturally have looked for, since the inner shape of the cranial casket in the Humming-bird is very different from the corresponding cavity in the Cypseli and Hirundines.

Another structure which need not detain us long is *the tongue*.

This organ is essentially alike in Swallows and Swifts; while, as we all know, in the Trochili it is more as we find it in the Woodpeckers, indeed very similar to those birds, for I find after careful microscopical examination that there is no truth in a statement still current that this long, slender tongue of *Trochilus* is a double-barrelled tube to suck honey with, but these supposed hollow tubes contain the prolongations of the cartilaginous parts of the glosso-hyal elements of the hyoidean apparatus.

With these few brief comparisons, which, however, are the expressions of long and painstaking dissections upon the heads of these several forms, I may state that, so far as this part of the economy is concerned, Cypseli and Trochili are *widely different in all particulars*, whereas Swifts show themselves to be but highly modified Hirundine birds.

Résumé of some of the Points in the remainder of the Axial Skeleton.

These I will tabulate in order to bring them into as bold relief as possible for direct comparison. In the Proc. Zool. Soc. 1885, I have already made some remarks upon the skeletons of *Micropus melanoleucus* and *Trochilus Alexandri*. Here, for variety's sake, we will take the Swift *Chætura pelagica* and *Trochilus rufus*; they are essentially and respectively much alike, at any rate the two first mentioned species, but I do this in order to show that my first comparisons still hold good for the proposed separate groups.

Chætura pelagica.	*Trochilus rufus.*
1. 12 cervical vertebræ that are without free ribs; 13th and 14th vertebræ possess freely suspended ribs; while from the 15th to the 19th they are *true dorsals*, connecting with the sternum by costal ribs.	1. 13 cervical vertebræ that are without free ribs; only the 14th vertebra possesses freely suspended ribs; while the 15th, 16th, and 17th are the only three free vertebræ in the dorsal region which connect with the sternum by costal ribs. The 18th and 19th likewise do; but I here propose to consider these two latter ones as *leading sacrals*, as they evidently belong to that bone. This gives *Trochili* but *three true dorsal vertebræ*, quite as few as any other existing bird, and it is all they have.
2. The last sacral vertebra is the 29th.	2. The last sacral vertebra is the 27th.

Chætura pelagica.	*Trochilus rufus.*
3. The last caudal vertebra is the 35th.	3. The last caudal vertebra is the 32nd.
4. Pelvis much as we find it in some Swallows; leading sacral vertebra does not markedly project beyond ilia.	4. Pelvis peculiarly formed; and two entire vertebræ project beyond the ilia (the 18th and 19th).
5. Sternum untouched posteriorly; possesses comparatively large costal processes; small manubrium; deep carina; which latter and the body are *always* riddled with large vacuities.	5. Sternum unnotched posteriorly; very small costal processes; no manubrium; comparatively a much deeper carina; sternal body and keel never perforated by vacuities.
6. Os furcula a very broad U-shaped one, with lateral abutments at its heads, and with rudimentary hypocleidium; the bone harmoniously proportioned for the rest of the skeleton.	6. Os furcula rather of a very broad V-shaped variety, with small lateral abutments at its heads, and with rudimentary hypocleidium, with the bone of hair-like dimensions as compared with others of the skeleton.
7. Coracoids much of the same form as we find them in the Swallows.	7. Coracoids very peculiar, as the tendinal canal is closed by bone, and the shaft perforated by a large foramen below it. *Totally* unlike the bone in the *Cypseli*.
8. Blade of scapula nearly straight.	8. Blade of scapula bent at a marked angle at its posterior extremity.
9. General aspect of the body skeleton, aside from the unnotched sternum and rather deep keel to it, like the *Hirundinidæ*.	9. General aspect of the body skeleton has no exact counterpart among living birds, that the writer has as yet ever met with.

Now a few words as to what the above table shows: first, it is evident that the spinal column of Swifts and Humming-birds is fundamentally different, both in the number and arrangement of the vertebræ. It should, however, be stated that upon going over a large number of specimens, I find that it is the 15th vertebra that first connects with the sternum by costal ribs, and not the 16th as stated in my first contribution of 1885. This gives the Trochili 3 true dorsals, which is as small a number as any existing bird possesses; I found the same number in a Californian Condor. Cypseli *possess 5 true dorsal vertebræ.*

Some excellent characters, no doubt, are to be obtained from any bird's sternum, but the more I look into it the more I am convinced that the facility with which we can say sternum 2-notched, sternum unnotched, sternum 4-notched (as the case may be) has almost proved a detriment to avian taxonomy, for, being satisfied with that (taken in connection with a few other salient characters), very often the rest of the bird's economy has not been examined nor even taken into consideration at all. Why the pelvis has not proved an equally valuable character in the list of classificatory characters, is simply because the systematist cannot so readily say pelvis 2-notched, pelvis unnotched, and so on. Yet the pelves of birds, when carefully compared, offer fully as good distinctive characters for taxonomic purposes as the sternum. I have already pointed out the fact that the pelvis of a *Trochilus* is as different from the pelvis of a *Cypselus* as any two birds' pelves can well be. Further, their sterna, when we really take all their characters into consideration, apart from the fact that both happen to be unnotched, are very differently fashioned bones. Both are unnotched, to be sure,—but so are the sterna of some Petrels! Were the fact that the sterna of both Cypseli and Trochili are unnotched of any significance, so far as affinity is concerned, then surely the remainder of the organization in these birds would be more or less in harmony, and not at the widest variance, as is the case! What I mean by this is easily shown in the shoulder-girdles of the two types in question: thus, the coracoid of a *Trochilus* is a very uniquely-formed bone (P. Z. S. 1885, pl. lx. fig. 5), and very different from the great majority of birds. In the Swifts the coracoid is like that of the Swallows. Again, the scapula in *Trochilus* is unlike the corresponding bone in a Swift: consequently, this being the case, I attach little or no importance, so far as affinity is concerned, to the fact that their furculæ happen to possess some marked resemblance. For we well know that this latter component of the girdle is that which becomes modified in accordance with the flight of its owner, while the coracoid can be far better relied upon for any affinity it may show as a character amongst forms more or less related. Swifts are birds of long-sustained flight, Humming-birds are great fliers, and so are Albatrosses; and were we to increase in size the os furcula of a Swift and a Humming-bird to the size of the bone in an Albatross, we should be surprised to find how much they resemble each other.

Seeing now how very different the thoracic and pelvic, or really the trunk-skeletons of Swifts and Humming-birds actually are, let us next examine into some of the organs and viscera which they enclose.

The Heart and Carotids, Trachea, Viscera, &c.

Cypseli as a rule possess but a single carotid, the left one; Professor Garrod, however, discovered that *Cypseloides* proved an exception to this. In *Chætura* I found but one, which was disposed along the anterior aspect of the neck in the most usual manner; while in *Micropus melanoleucus* the left carotid, here also the only one present, takes on a peculiar course, for being so far over to the left, it passes up to the front of the neck obliquely, and completely outside the protection of the muscles and the hypophysial canal of the vertebræ.

Past the middle point of the neck, however, it enters between the muscles to the aforesaid canal, and then follows the usual course to the head.

Swifts do not possess a heart of any unusual dimensions; but Humming-birds, on the other hand, have a heart quite as unproportionately large for their size as are the feet of these, the otherwise pygmies of the Class. They too have but one carotid, so far as I have examined, the left one alone being represented.

MacGillivray, in Audubon's 'Birds of North America,' under the latter's account of *Trochilus colubris*, presents us with a very good description of the trachea in a Humming-bird. He says of it that "The trachea is 9 twelfths long, being thus remarkably short on account of its bifurcating very high on the neck, for if it were to divide at the usual place, or just anteriorly to the base of the heart, it would be $4\frac{1}{2}$ twelfths longer. In this respect it differs from that of all other birds examined, with the exception of the Roseate Spoonbill (*Platalea ajaja*), the trachea of which is in so far similar. The bronchi are exactly $\frac{1}{2}$ inch in length. Until the bifurcation, the trachea passes along the right side, afterwards directly in front. There are 50 rings to the fork; and each bronchus has 34 rings. The breadth of the trachea at the upper part is scarcely more than $\frac{1}{2}$ twelfth, and at the lower part considerably less. It is much flattened, and the rings are very narrow, cartilaginous, and placed widely apart. The bronchial rings are similar, and differ from those of most birds in being complete. The two bronchi lie in contact for 2 twelfths at the upper part, being connected by a common membrane. The lateral muscles are extremely slender. The last ring of the trachea is four times the breadth of the rest, and has on each side a large but not very prominent mass of muscular fibres, inserted into the first bronchial ring. This mass does not seem to be divisible into four distinct muscles, but rather to resemble that of the Fly-catchers, although nothing certain can be stated on this point." My own investigations upon other species than *T. colubris* go towards establishing in the main this admirable description of a very painstaking anatomist, for whom I have always entertained the highest regard both for his character and his work. It is needless to add that such a trachea, the counterpart of which is seen only in the Spoonbill, is sufficiently far removed from the form it assumes in the Cypseli to satisfy the most sceptical as to any affinity on that point! In Swifts it *does* bifurcate "at the usual place;" it possesses but *two* pairs of muscles (the lateral ones, and those that go to the sternum), and in all other points is widely and fundamentally at variance with the windpipe and bronchi of the Trochili.

Careful as MacGillivray's account is, however, he neglected to mention one very important difference, so far as these parts are concerned in the birds under consideration, and that is, the Trochili constitute one of those rare groups which lack the pair of *sterno-tracheales* muscles; I carefully searched for them in several species of Humming-birds, but failed to find them, and am quite convinced they do not exist.

If the reader will kindly turn to figure 33 of Plate XXIII. illustrating this memoir, he will find my drawing of the trachea of a Humming-bird, and in figure 35 the position it occupies in the thorax and neck with respect to the other organs.

Indeed, in figures 35 and 36 I have drawn the bodies of a Humming-bird and a Swift, after having carefully removed the pectoral muscles and sternum, in order to show this very thing. A glance at these two figures will be sufficient to satisfy any one as to the remarkable difference they present. In the Humming-bird, we are struck at once by the position of the trachea; the *direct* course of the left carotid, the *enormous heart*, and the fact that the low position of the liver conceals from our sight all the other viscera harboured in the abdominal cavity. Here, as in most birds, the right lobe of the liver is the larger of the two, which in the Humming-bird, as we see, curls round the apex of the heart (more so in *T. platycercus*), modelling itself to that extremity of it. Still more at variance, as compared with the Swift, is the *digestive tract* of a Humming-bird, for, so far as I am familiar with the morphology of the group, in none of them do I know of a species which possesses, as compared with the size of its intestines, so exceedingly small a stomach! This organ, together with the relatively large intestine, with, too, its bulbous cloaca, I have represented in figure 34.

Swifts possess a stomach, both in position and general form, very much like the Swallows, and, as we now know, nothing at all like the Trochili. True, neither Cypseli nor Trochili possess intestinal *cæca*; but does this mean anything when no other two organs in the bodies of these birds have any resemblance to each other whatever, so far as affinity is concerned? Look at them in the figures; are there many birds in the Class more widely separated in this respect than these Swifts and Humming-birds?

Upon laying open the stomach of a specimen of *Micropus melanoleucus*, I found it packed full of insects; but, what is more important, anatomically speaking, I discovered it to be lined with a tough, corneous, inner coat, which was lifted out *entire*, by simply using very gentle traction, with a pair of dissecting-forceps. The stomach of the Humming-bird was also full of the tiniest Coleoptera imaginable, which were very interesting to study under a two-inch objective attached to my Beck's binocular microscope, and I wondered as I did so whether all these tiny New-Mexican beetles were known to science.

Apart from the fact, then, that Cypseli and Trochili agree in certain numerical and negative characters ("a single carotid, and no cæca," dangerous facts sometimes!), these birds are by no means related, so far as the organs we have just been investigating are concerned.

Having now passed in review the characters of a Passerine bird (*Ampelis cedrorum*), and gone very carefully over the osteology of certain Trogons, and even yet more thoroughly over the structure of many *Caprimulgi*, Swallows, Swifts, and Humming-birds, I believe, as my views have been slowly formulating during my painstaking dissections, that I am now in a position to reconsider what I have already published upon the classification of the MACROCHIRES, as well as to present the conclusions at which I have now arrived, aided as I have been by all this recent research. Before doing this, however, I desire to present in a few paragraphs the results of my investigations upon two specimens of *T. Calliope*, nestlings only a day or two old, and for which I am indebted to the generosity of Mr. F. Stephens, of San Bernardino, California, who sent them to me to be used in the present connection. One of these little fellows I drew, life-size, and it will be found figured on Pl. XXIII.

fig. 32, which gives its external characters sufficiently well to obviate the necessity of a special description. Among the most interesting of these features is the wonderfully short beak in this nestling, as compared with the long slender one of the adult.

Supplementary Notes on Cypseloides niger *and* Nyctidromus albicollis, var. Merrilli.

As this paper is passing through the press I am able to add a few words upon the structure of these two birds—the Black Swift and Merrill's Parauque. This affords me particular satisfaction, for inasmuch as every species of American (*i. e.* United States) Swallow (seven in all) is anatomically described in this memoir, I can add that I have similarly examined and compared every species of Caprimulgine (except *A. carolinensis*) and Cypseline bird. I am indebted to my friend Professor Newton, F.R.S., of Cambridge, for the specimens of *Cypseloides*, which were collected for him on my behalf in Jamaica by Mr. G. A. Waddington. The specimens of *Nyctidromus* are from Texas, where they were procured on the lower Rio Grande by two of my collectors.

Externally *Cypseloides niger* has a more Swallow-like appearance than either *Micropus* or *Chætura*. This no doubt is due to the structure of the tail and feet, which have a more passerine appearance than is seen in *M. melanoleucus*, and still more so than in *C. pelagica* or *C. Vauxi*. Nevertheless *Cypseloides* is a Swift, with the pterylography of the order as given above. It also exhibits the peculiar black pigmentation on the palmar aspects of its pinions, although the skin there is not quite so dark as in other North-American Cypseli. The tarsal and pedal integuments are skinny, but plainly show a scutellate definition. The hind toe is somewhat elevated, though distinctly posterior in position. In general form the plucked body presents the appearance of the nude body of a *Chætura* rather than of *Micropus*, which is more compressed in shape.

Myologically, this Swift agrees with others already described, the patagial muscles, the muscles of the thigh, and thorax being almost identical with those of *C. pelagica*.

Upon opening the abdominal cavity we find that in these parts also *Cypseloides* agrees with all true Swifts. The stomach is notably large, and only overlapped by the lobes of the liver above, in all these respects differing widely from the corresponding organs in any existing Humming-bird.

In the anatomy of its air-passages, its heart and vascular system, this Black Swift is likewise typically Cypseline.

Coming to the skeleton, I find *Cypseloides* in its osteology agrees in the main with the group of birds to which it naturally belongs; that is, it is essentially a Swift so far as this part of its organization seems to indicate; nevertheless, in several particulars it has a skeleton nearer the Swallows than has either *Micropus* or *Chætura*. It has, for instance, the interorbital septum much as we find it in the *Hirundinidæ* generally, and a large sesamoid at the elbow, as in Swallows. But, what is still more significant, it has the vacuities, one on each side of the posterior mid-end of the premaxillary above, just beyond the frontal region, filled in by a thin continuous layer of bone—agreeing in this particular respect with the Barn-Swallow (*C. erythrogaster*). *Cypseloides*, moreover, has its external narial apertures more circumscribed, or, in other words, more as we find them in certain Hirundines (see figures 22 and 23, Plate XXI.).

Having compared the skeleton of *Nyctidromus albicollis* var. *Merrilli* with the skeletons of the other Caprimulgine birds of the U.S. avifauna which I have described on former occasions, I find that it agrees more nearly with the American Whip-poor-will (*Antrostomus vociferus*) than with any other. Osteologically, however, it may be found to agree still more closely with the "Chuck-will's-widow" (*A. carolinensis*), but as yet I have not had the opportunity of comparing it with that bird.

The entire order of the CAPRIMULGI stands much in need of thorough revision, and extensive researches into structure will be required before we can know much of the true relationships and proper classification. I am convinced that, so far as the United-States forms of this group of birds are concerned, there are certainly two very well-defined subfamilies of the *Caprimulgidæ*. From what we know of their external characters, and from what I have shown of their widely different internal structures, these might readily be characterized as the subfamilies *Antrostominæ* and *Chordeilinæ*—the former to contain the genera *Antrostomus*, *Phalænoptilus*, and *Nyctidromus*; the latter the genus *Chordeiles*.

We have but to compare the skull of Nuttall's Poor-will (*P. Nuttalli*, Plate XX.) with the skull of *Chordeiles acutipennis* var. *texensis* (P. Z. S. 1885, pl. lix.) to be convinced of the wide differences which exist in this part of the skeleton in these two very distinct kinds of Goatsuckers, and this, as we now know, is sustained by other parts of the structure of the birds in question. In this connection, however, I may add that I have recently examined a nearly adult specimen of *Chordeiles virginianus*, kindly procured for me by Dr. W. S. Strode of Bernadotte, Illinois. In this I find that the maxillo-palatines do not meet in the median line, but are pressed close against the sides of the *vomer* on each side. This latter bone is bifurcated behind, and into the fork the antero-median point of the palatines is wedged. The vomer comes well forward, anteriorly, where it is bluntly pointed and thicker than it is behind. It is only in the immature bird that these true relations can be studied, for in all species of this genus, as they attain to maturity, these several bones indistinguishably fuse, and present the appearance shown in the basal view of the skull of *Chordeiles acutipennis* var. *texensis* (P. Z. S. 1885, pl. lix. fig. 4), where, however, the *vomer* is not quite correctly indicated, for the lines designated by *Vo* go to the mesial fused portion of the palatines, and not to the vomer, which in that skull is co-ossified with the maxillo-palatines, and only its median line and anterior apex are seen.

Anatomical Notes upon the Nestling Trochilus, *a day or two old.*

First, I remove the delicate skin from the specimen's head, and note that the ends of the *hyoidean apparatus* have not proceeded beyond the posterior area of the parietal region, and that, although *the tongue* is short, still it shows well the embryonic condition of the two glosso-hyoidean rods which become so long in the adult Humming-bird.

The *nasal bones* lap rather high up on the frontal region, and mesially meet the backward-extending limb of the premaxillary for their entire borders, thus leaving no vacuity in this locality, as is to be seen in the postero-culmenar space of the superior aspect of the upper mandible in an adult *Cypselus*.

In size, the *lacrymal* bones are exceeding small, and I am inclined to think that were we able to define their sutural boundaries in the skull of the adult, we should find that they contribute but a meagre share to the wide expanse of bone in the pars plana of the mature *Trochilus*.

At the base of the skull we note that the tiny palatines, the jugals, quadrato-jugals, and even pterygoids are now considerably ossified; and that the latter elements are separated at their palatine heads quite as much in proportion as we find them in adult skulls.

The *premaxillary* and *mandible* are also largely formed in bone, more especially their tips and backward-extending limbs.

Removing the skin from the back, I carefully count the vertebræ of the column two or three times, distinguishing 35 segments, from which we may judge that 3 vertebræ are incorporated in the *pygostyle* of the adult.

Without any difficulty whatever, and by the aid of a 2-inch objective, I clearly make out the arrangement of the muscles of the fore limb, and distinctly perceive the tendon into which the tensor patagii brevis is inserted. Even still better can be seen the muscles of the thigh, where the biceps seems to arise by a double head from the pelvis, but otherwise the myological formula here is the same as I stated it above for the adult *Trochilus.* The plantar tendons also confirm all that is recorded in a preceding paragraph.

Coming next to *the sternum*, I find that even at this tender age the posterior margin of the body of the bone is rounded and unnotched. Six *costal ribs* articulate, on either side, with a "costal border."

At the side of the neck in this specimen the œsophagus was much distended by a small spider and two small beetles; but I believe that this represents food that the little bird had not swallowed at the time of its death, and that naturally no enlargement takes place in the œsophagus at the point in question.

We note that the bifurcation of the *trachea* is situated fully halfway up the neck towards the throat in this nestling, so that if the upper moiety of the anterior cervical region happens to be covered with the finger at the time of microscopical examination, one is momentarily impressed with the notion that the bird has two tracheæ, so unusual is this arrangement in the Class *Aves.*

Upon opening the thorax and abdomen, it disclosed the fact that the *sterno-laterales* muscles of the trachea are not present, and I am inclined to believe that *Trochili* do not possess them. Further, we find the heart is in about the same position and relative size as it is in the adult; but the *lobes of the liver* are proportionately much smaller, so much so that we can easily examine the intestines and stomach below their hinder borders without disturbing them, which is not possible in the adult.

On the other hand, *the stomach* is proportionately much larger in this nestling than it is in the parent bird (to be of any use, it could scarcely be of a relative size), and in the present case was crammed full of insects.

Conclusions.

Before touching upon the real object of the present memoir as stated in its title, in these my final conclusions, I will briefly allude to what may be gathered from my investigations as set forth in the earlier sections of this paper, touching the morphology of representatives of certain outlying groups to the Macrochires. At the outset, believing it would be an advantage to pass in review the structure of a suitable and average Oscinine bird, I chose *Ampelis cedrorum* for reasons already fully stated; and, in addition to the advantage of having its structural characters before us in the present connection, my brief account of its anatomy, it is to be hoped, will prove useful in other particulars, more especially in throwing some light upon its own probable relations to the Clamatorial birds and the *Hirundines.*

It is believed that the account tends to show that structurally *Ampelis* presents no special affinity with the Swallows, while in some respects it links the Mesomyodian birds with the Oscines, though nearly all its entire organization points to its more intimate relations with the latter group.

Judging from osteological premisses alone, it is very evident that such forms as *Trogon puella* and *T. mexicanus* can claim no special relationship with the *Trochili*, while, on the other hand, I consider that their affinity with the Caprimulgi is also very remote. Further than this their kinship at present concerns us not, as it does not especially bear upon the work in hand; nor, even were I so disposed, would I hazard an opinion in any such direction, until I had fully investigated the structure of other birds specimens of which, up to the present time, it has not been my good fortune to possess, nor, in many instances, even to see. How much Cuckoo stock they possess in their economy is another point which can only be settled, if ever, by exhaustive researches into the anatomy of the more aberrant Cuculine types; it is more probable that they, the Trogons, came up through some such tribe as the latter, than through any other with which I am acquainted.

Still, and to hold this end of the thread for a moment longer, it is difficult to see any near relationship between such a bird as *Trogon puella* and *Geococcyx californianus* for instance. Surely there must be a gap of no mean width when we come to push them in that direction. Not long ago I published (Proc. Zool. Soc. for 1887) some contributions to the anatomy of *Geococcyx*, wherein, in my conclusions, I pointed out what appeared to be the correct classification of the United States Cuckoos, supporting Garrod's original suggestion of placing the true Cuckoos and Ground-Cuckoos in separate subfamilies. Still maintaining, as I do, this opinion, I am free to confess that I consider the subfamilies to be thus represented *markedly distinct*, to say the least of it. For instance, how close to such a bird as *Coccyzus minor* may *Geococcyx* be? Notwithstanding the zygodactyle foot in the latter (a character sometimes of uncertain meaning), I have always entertained the notion that some day we may see an affinity between *Geococcyx* and the *Daceloninæ*, as in *Dacelo gigantea*; or, carrying it a little further, a certain kinship with the *Galbulidæ*, more particularly those which possess the two carotid arteries and the myological formula A . XY. But here, again, the proper material has never yet been at my disposal.

Since the appearance of my first contribution to the present subject (P. Z. S. 1885), nothing has arisen in the course of my more extended researches which has in any way modified my original opinion in regard to the Caprimulgine birds, nor have I anything to add to what I have already stated in the body of the present memoir. They constitute the first group which I propose to remove from the old Order PICARIÆ, and for them I create a separate Order, the CAPRIMULGI, first alluded to in my previous paper, to contain all the true Caprimulgine birds of the world, including such types as *Steatornis*, *Podargus*, *Ægotheles*, *Nyctidromus*, *Nyctibius*, *Psalurus*, and others.

These birds have their nearest kin in the Owls, and they have no special affinity with the Cypseli, much less with the Trochili. With our present knowledge of their structure, these Caprimulgine forms may easily be relegated within this Order to their proper family and subfamily positions, and in a way, too, I think, that would meet the approval of all, as it would be based entirely upon the structural characteristics of the several and respective types, the best and only guide in such matters.

Coming now to the *Hirundinidæ*, I see in these fissirostral Oscinine Passeres a group of birds, which, although they still possess in their organization a majority of the structural characters of the original Passerine stock, have long since deviated from the latter. They are true Passeres considerably modified, which modifications in several instances may be traced to the adoption of new habits, and are really physiological adaptations of structure. For instance, through ages of time they no doubt have gradually attained their increase of size in the gape, which enables them to take insect prey upon the wing with greater certainty and ease, and at the present time constitutes one of their best distinctional characters.

Whatever may be the physical principle involved that seems to demand a brevity of the brachium to suit their flight, we certainly can now perceive that a proportional shortening of the humerus is going on. Their flight, however, is not of such a vigorous nature as yet to demand much increase in the size of their pectoral muscles, and the consequent deepening of the carina of the sternum for their due attachment, nor the unnotched body of that bone to afford a more stable surface for the origin of those muscles. But with the present configuration of the countries they inhabit, and where their food is now to be had in abundance, no doubt they will long retain their present habits, and consequently their present structural organization.

Suppose, however, at some time in the world's history, ages ago, there were certain large areas inhabited by the original Hirundine stock, sufficiently differentiated from the existing Passerine types, in which from some cause there was a diminished supply of natural food—the insects which they had been accustomed to take on the wing. This would at once seem to demand in the organization of the Swallows an increased *rapidity of flight*, in order to secure for themselves and their young sufficient food during the course of the day. It would also lead, perhaps, to an increase in the size of the mouth, that this food might be captured with greater certainty. Further, they would probably be obliged to remain longer upon the wing. Continued for a sufficient length of time, such causes would be sure to work structural changes in the economy of these birds, and modifications would in consequence follow in their *wing-structure*, in the size and strength of their pectoral muscles, with an increase of the bony surface of the sternum, both in body and carina, from which these latter muscles arise; and finally, among certain other minor changes, we might find in consequence of the last-named requirement a suppression of parts in the *feet* and certain muscles of the *pelvic limb*, as the owners would now rarely perch or walk.

And this is the way, I suspect, that certain forms which we now see in our modern Swifts were differentiated from the early Hirundine stock. That this occurred early in the chapter of avian life-history, for the world is old, may be conjectured from the fact that Cypseli are now quite cosmopolitan birds, and, moreover, have many representatives among them which present highly specialized organization. Even at the present time, however, we yet have forms that structurally are nearer the Swallows than others of the same group. To instance this, we have but to glance at two such birds as *Micropus melanoleucus* and *Chætura pelagica*, in the first of which we still find the general Swallow-like form of the body, the average depth of the carina of the sternum, the non-pneumatic humerus, and other points, all of which are far more Cypseline in character in the latter bird. *Chætura*, too, agreeing with other spine-tail Swifts, shows its greater fixedness of characters in the very structures which gives it its name, for the spines which terminate its rectrices are useful to the bird, yet can only have been developed through ages of time. When we come to examine the still more Swallow-like Swifts, *Hemiprogne* for example, and its allies, I am sure we shall meet with other points in their anatomy which will lend support to this view of the origin of these types.

In the present memoir I have, by extensive and careful comparative investigations into structure, attempted to point out how entirely different these Swifts are from the Hummingbirds, a group with which they have long been associated, to my mind upon very meagre claims. During the course of my present researches I have shown that Cypseli differ from Trochili, (1) in their habits; (2) in their nidification; (3) in the method of securing their food; (4) in all their external characters, and markedly in their external form; (5) in their pterylosis; (6) fundamentally in their skeletons; (7) every structure in their heads is as widely at variance as any two forms of birds in the Class; (8) in their wing-structures; (9) in their pelvic limbs; (10) in their respiratory apparatus; (11) in their visceral anatomy; and (12) in their digestive system. These two groups have been associated together upon an entirely false system of classification, which assumed first, that they are alike in their wing-structure—a resemblance which I have shown to be purely *superficial*; secondly, that they both have an unnotched sternum, although physiological law demands it, and when associated with an entire organization that widely differs from that of another form which may happen to possess an unnotched sternum, it means nothing so far as affinity is concerned. This becomes the more evident when the sterna themselves are fashioned upon essentially different plans, as is the case in the Cypseli and Trochili.

Truly related organizations *never* exhibit such an array of inharmoniously associated sets of morphological characters. And it is to the detriment of comparative anatomy, and all we may hope to effect by it, to summon to our aid such characters as "shortness" (in the case of the humeri), as "presence" or "absence" of parts (as intestinal cæcæ), and other matters of purely physical or arithmetical interest, unless there can be shown in connection therewith actual similarity in form and arrangement of parts.

Now in my first memoir (Proc. Zool. Soc. 1885) upon this subject, I proposed that in the Passeres the Cypseli should be placed next to the *Hirundinidæ*; for convinced, as I was, of their relationship, I for the moment did not take into account the artificial boundary lines of orders, genera, and what not, demanded on the part of systematists, simply having in my mind (after working many weeks over their several structures) their affinities, and not how they really ought to figure in print.

Evidently this will not do, and we must assign them some position in the system which they can occupy with propriety in ornithological works, even if it does a little violence to the delicate and intricate kinships, which the morphologist can so often see with his mind's eye, but which sometimes look so startling in type.

There is but one way at present open to us to effect this, and that is, all the true Swifts in the world must have a group or an order created for them, as the order Cypseli, which I now propose for their reception. This Order, were it represented by a circle, would be found just outside the enormous Passerine circle, but tangent to a point in its periphery opposite the Swallows, which latter are to be found just over the line of the arc.

For the Trochili I have already proposed a separate order in a former communication, and am to-day more convinced than ever of the correctness of that proposal.

The time may arrive when we shall see more clearly the relationship to other groups of birds of these markedly modified and highly interesting little forms, but in the meantime a very great amount of painstaking dissections upon avian types will have to be successfully undertaken. Agreeing with the Psittaci in this particular, I am inclined to believe that the order TROCHILI will be found to be an unusually well-circumscribed one, containing upwards of 500 species, to represent it.

Since completing the main part of this paper, and especially since closing the list of acknowledgments at its commencement, I have received many kind letters relative to the work from fellow labourers in the same fields, and in some cases valuable material for comparison.

Chief among these it gives me great pleasure to thank Professor W. K. Parker, F.R.S., for many timely hints upon avian relationships, and for his ready encouragement of my work during the time it has been in progress. I am grateful, too, to Sir Edward Newton, C.M.G., formerly of the Colonial Office, of Kingston, Jamaica, for his efforts to secure me specimens of *Hemiprogne zonatus*; to Lieut. Edgar A. Mearns, of the Medical Corps of the United States Army, for specimens of Humming-birds from Arizona; to Mr. Robert Ridgway for having directed that the entire collection of birds in alcohol at the Smithsonian Institution should be gone over with the view of filling up gaps in my desiderata, although at that time it was found that no specimens in alcohol of the Macrochires were in the collections of that Institution; and finally, to Mr. F. Stephens, of San Bernardino, California, for the loan of many valuable sterna of American Trochili, from his private collections.

EXPLANATION OF THE PLATES.

(All the figures in the Plates were drawn by the Author from the specimens.)

PLATE XVII.

The pterylosis of *Ampelis cedrorum*.

Fig. 1. *a*. Ventral aspect. *b*. Dorsal aspect. Considerably reduced.

2. Muscles of the patagium of the right wing in *Ampelis cedrorum*, seen upon the outer aspect, and × 2. *tp. l*, tensor patagii longus; *tp. b*, tensor patagii brevis; *dt. p*, dermo-tensor patagii; *d*, deltoid; *t*, triceps; *b*, biceps; *e. m. r. l*, extensor metacarpi radialis longus; *h*, humerus; *u*, ulna.

3. Right lateral view of the skull of *Tyrannus verticalis*, ♂; life-size. *l*, the free lacrymal bone.

4. Same view of the skull of *Ampelis cedrorum*, ♂; life-size: letters the same.

5. Same view of the skull of *Hesperocichla nævia*, ♂; life-size.

Fig. 6. Under view of the skull of *Ampelis cedrorum*, ♂; × 2. *pmx*, premaxillary; *mx. p*, maxillo-palatine; *pp.* pars plana; *pt*, pterygoid; *ju*, jugal; *q*, quadrate; 8, foramen for vagus nerve; 9, for the hypoglossal nerve; *i. c*, for the internal carotid; *q. j*, quadrato-jugal, *eu*, Eustachian tube; *pl*, palatine; *mx*, maxillary; *v*, vomer.

Plate XVIII.

Fig. 7. Pelvis of *Ampelis cedrorum*, × 2; dorsal aspect.

8. Basal view of the skull of *Trogon mexicanus*, × 2; the mandible removed. Lettering as in the preceding Plates, with *n. s*, nasal septum; * calls attention to the basipterygoid process of the right side.

9. Anterior aspect of the body of *Antrostomus vociferus*, to show the pterylosis. Somewhat reduced.

10. The same, shown from behind.

Plate XIX.

Fig. 11. Superior aspect of the skull of *Trogon mexicanus*; life-size, with mandible removed.

12. Ventral or anterior aspect of the sternum of the same species; life-size.

13. Right lateral view of the skeleton of the same; life-size, with the ribs of the left side removed.

14. Dorsal aspect of the pelvis of the same; natural size.

Plate XX.

Fig. 15. Left lateral view of the skull of *Phalænoptilus Nuttalli*, × 2. Collected by the author at Fort Wingate, N. Mexico. Lettering of the parts as on Plate XVII.

16. The same skull seen from above, × 2; mandible removed.

17. The same skull viewed upon its basal aspect; mandible removed; × 2.

Plate XXI.

Fig. 18. Right lateral view of the skull of a specimen of *Progne subis*, ♀; × 2. Lettering of the parts as before.

19. The same skull seen from above, × 2; mandible removed.

20. The same skull viewed upon basal aspect, × 2; mandible removed.

21. Basal aspect of the skull of *Chelidon erythrogaster*, ♂, × 2; mandible removed.

22. Superior view of the skull of *Micropus melanoleucus*, ♂, × 2; mandible removed: and letters as before. This drawing is made from the same skull as the one from which I drew the basal view in a former memoir on the *Macrochires* (P. Z. S. 1885, p. 899, fig. D).

23. Superior view of the skull of *Chelidon erythrogaster*, ♂, × 2; mandible removed: letters as before. This is the upper view of the skull shown in figure 21; and *x* directs attention to the thinning of the bone in the triangular area on either side, between the nasal, frontal, and premaxillary; in the Swift (fig. 22) this entire triangular area becomes completely perforate.

Plate XXII.

Fig. 24. Right lateral view of the skull of *Micropus melanoleucus*, ♂ ; × 2. Lettering of parts as before. This is the same specimen from which I drew the basal view in a former memoir on the *Macrochires* (P. Z. S. 1885, p. 899, fig. D).

25. Right lateral view (× 2) of the skull of *Tachycineta thalassina*, ♂. Lettering of parts as before.

26. Superior view (× 2) of the skull of *Tachycineta thalassina*, ♂ ; mandible removed. This figure and figure 25 refer to the same specimen from which I drew the figure in my former memoir (P. Z. S. 1885, p. 899, fig. F).

27. Right lateral view of the skull and mandible of *Trochilus rufus*, adult ♂ ; × 4. Same lettering as before.

28. Outer aspect of the muscles of the right arm in *Trochilus platycercus*. Very much enlarged. *t*, triceps; *tp. b*, tensor patagii brevis; *tp. l*, tensor patagii longus; *c. m. r. l*, extensor metacarpi radialis longus; *tn*, a tendon to the tensor patagii brevis.

29. Outer aspect of the muscles of the right arm in *Chætura pelagica*. Enlarged rather more than twice. Lettering same as in fig. 28. This figure and the last were drawn by the author directly from his own dissections.

Plate XXIII.

Fig. 30. Ventral aspect of the pelvis of *Micropus melanoleucus*, × 2.

31. Ventral aspect of the pelvis of *Trochilus rufus*, × $3\frac{1}{2}$.

32. Right lateral view, life-size, of a day-or-two-old nestling of *Trochilus Calliope*.

33. Anterior aspect of the trachea of *Trochilus rufus*, × $4\frac{1}{4}$.

34. Digestive tract of *Trochilus platycercus*, × $2\frac{1}{5}$.

35. Anterior aspect of *Trochilus Calliope*, adult, with the chest-wall and other parts removed to show the relative size and position of organs. *l. c*, left carotid; *H*, heart; *r. l*, right lobe of liver; *l. l*, left lobe of liver. × $2\frac{1}{4}$.

36. Same view and similar dissection of *Micropus melanoleucus*. *S*, stomach, with other lettering as in figure 35. Somewhat enlarged.

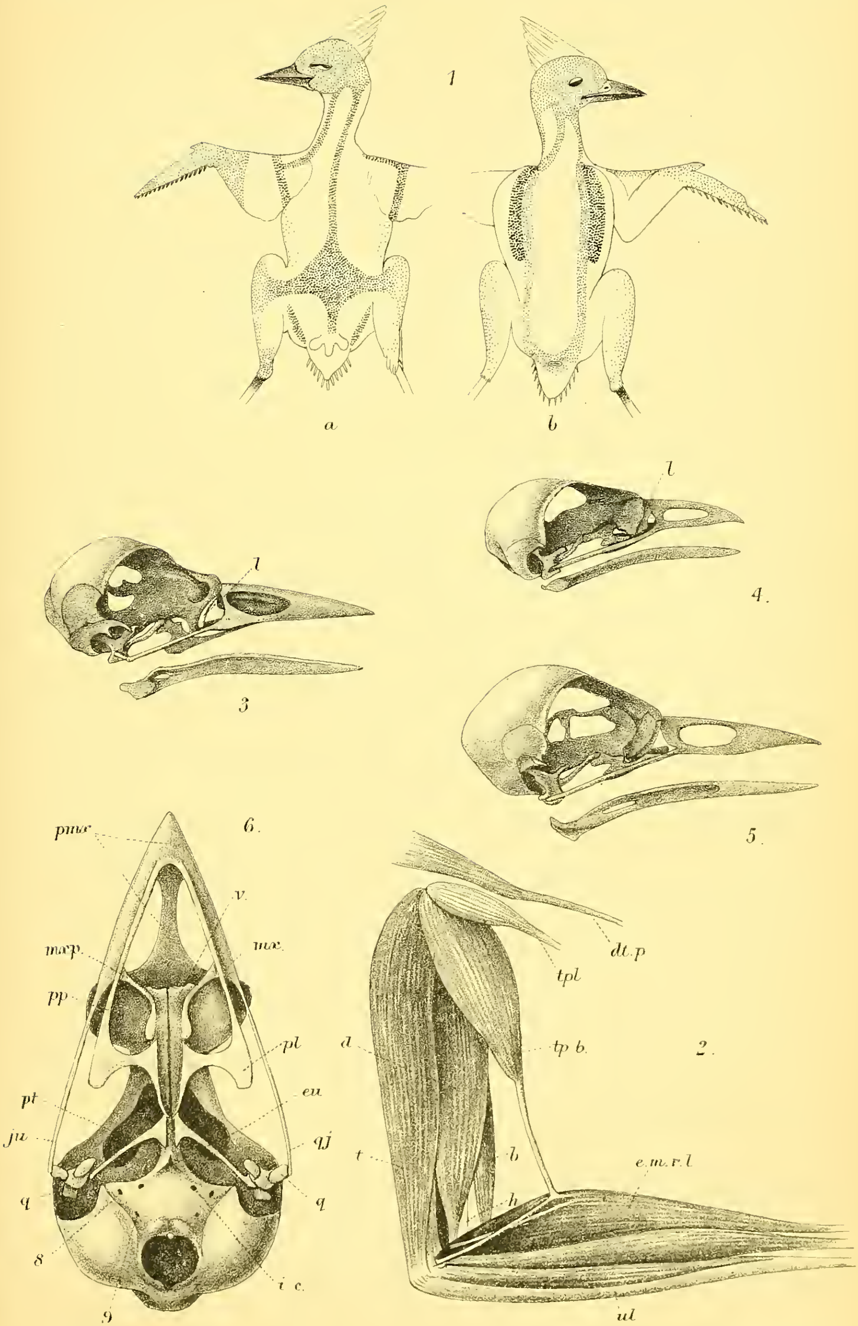
Plate XXIV.

Fig. 37. Left lateral view of a plucked specimen of *Micropus melanoleucus*.

38. The same of *Chætura pelagica*.

39. The same of *Trochilus platycercus*.

These are all life-size figures of male birds obtained by careful contour traces directly from the bodies of the specimens, and are not intended to show any part of the pterylography.



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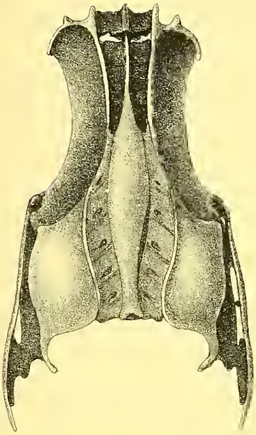

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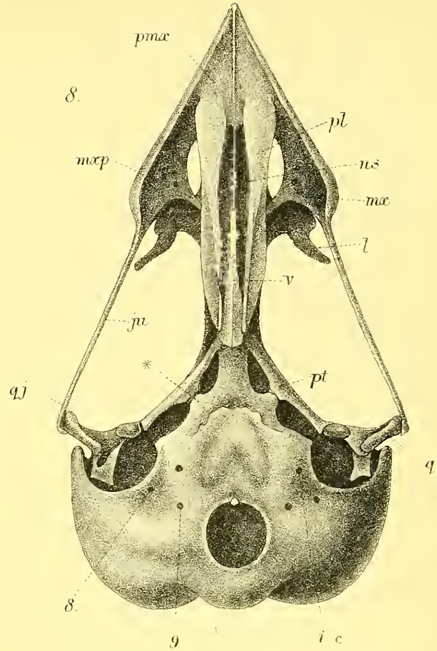

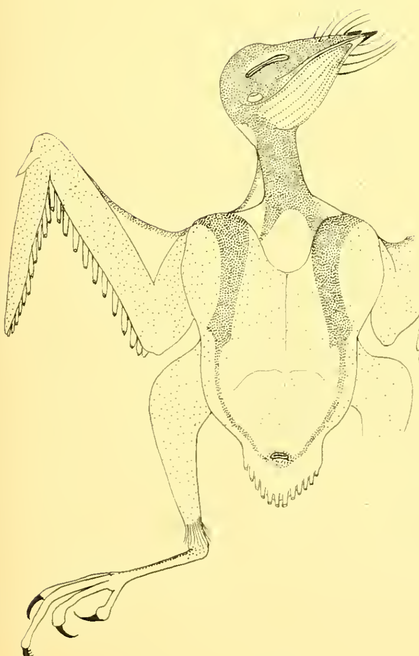

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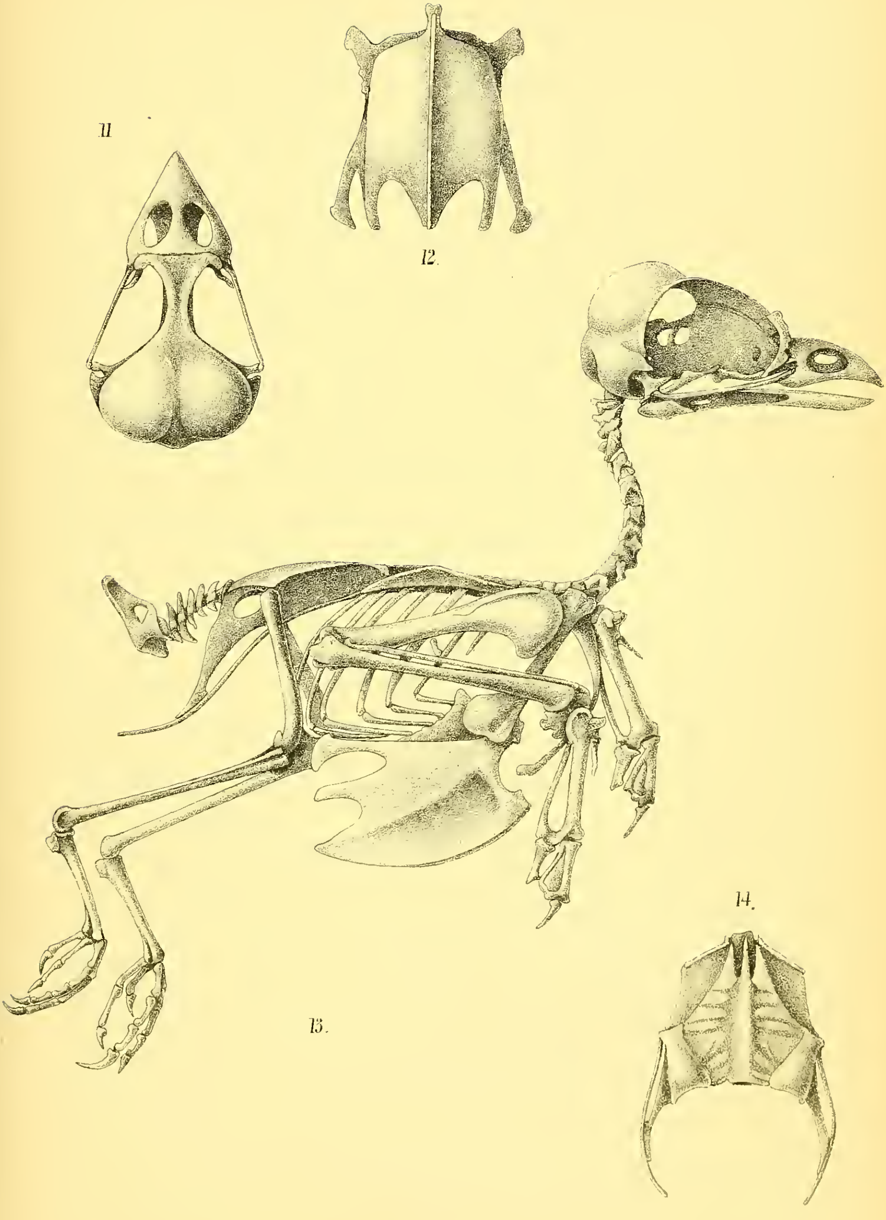

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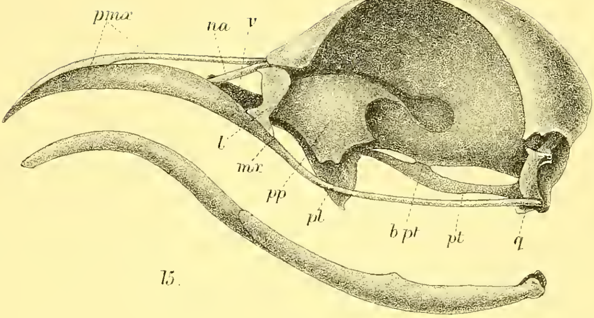

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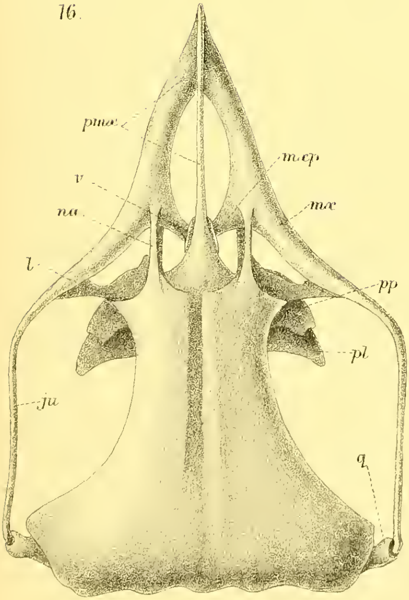

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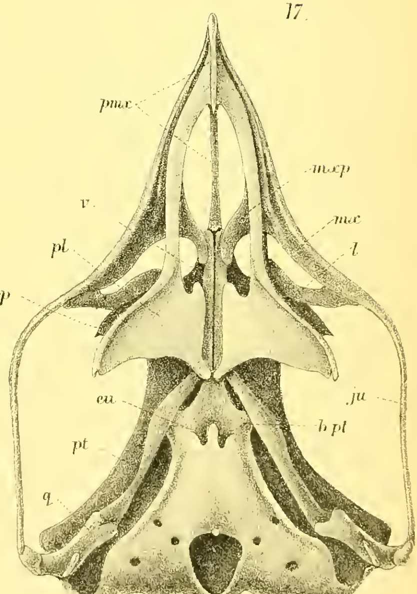

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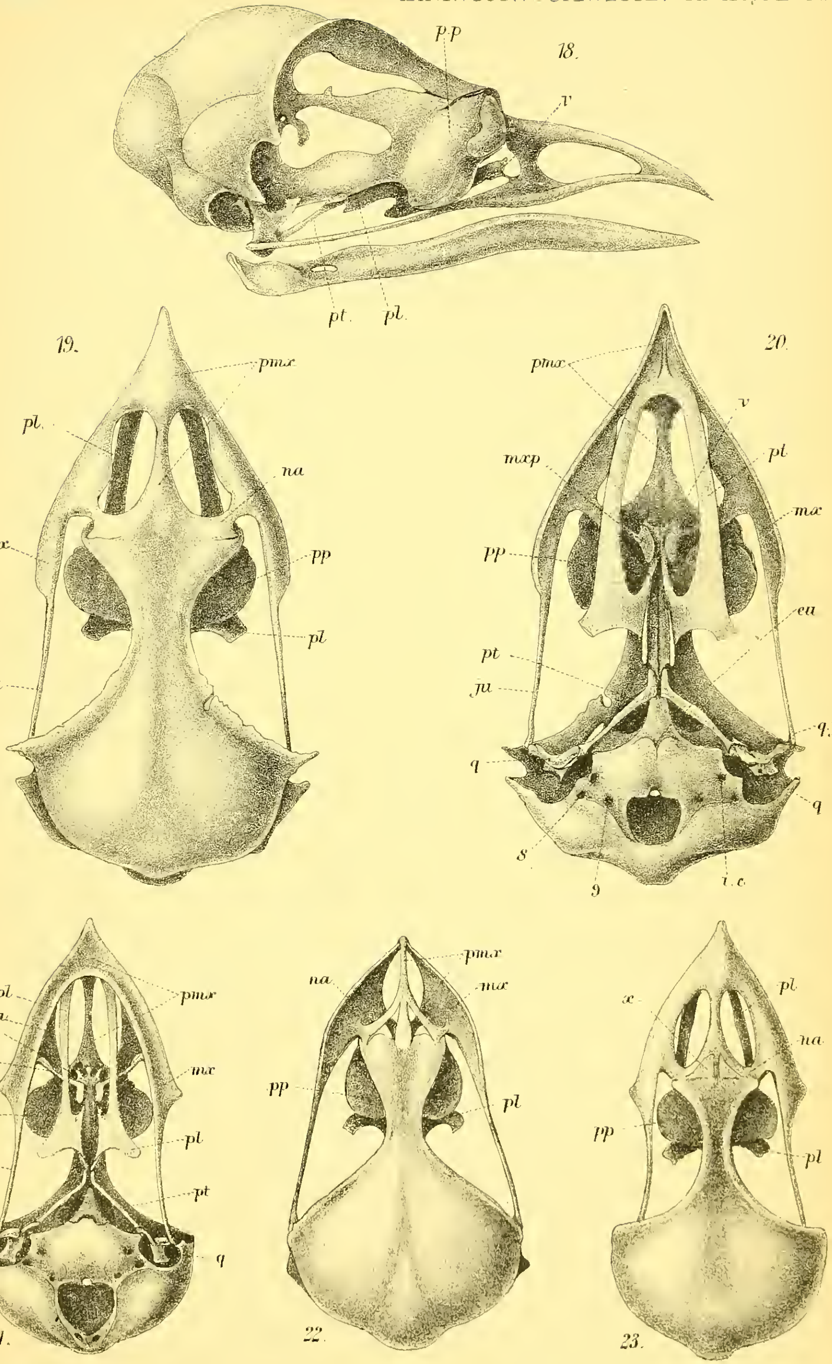

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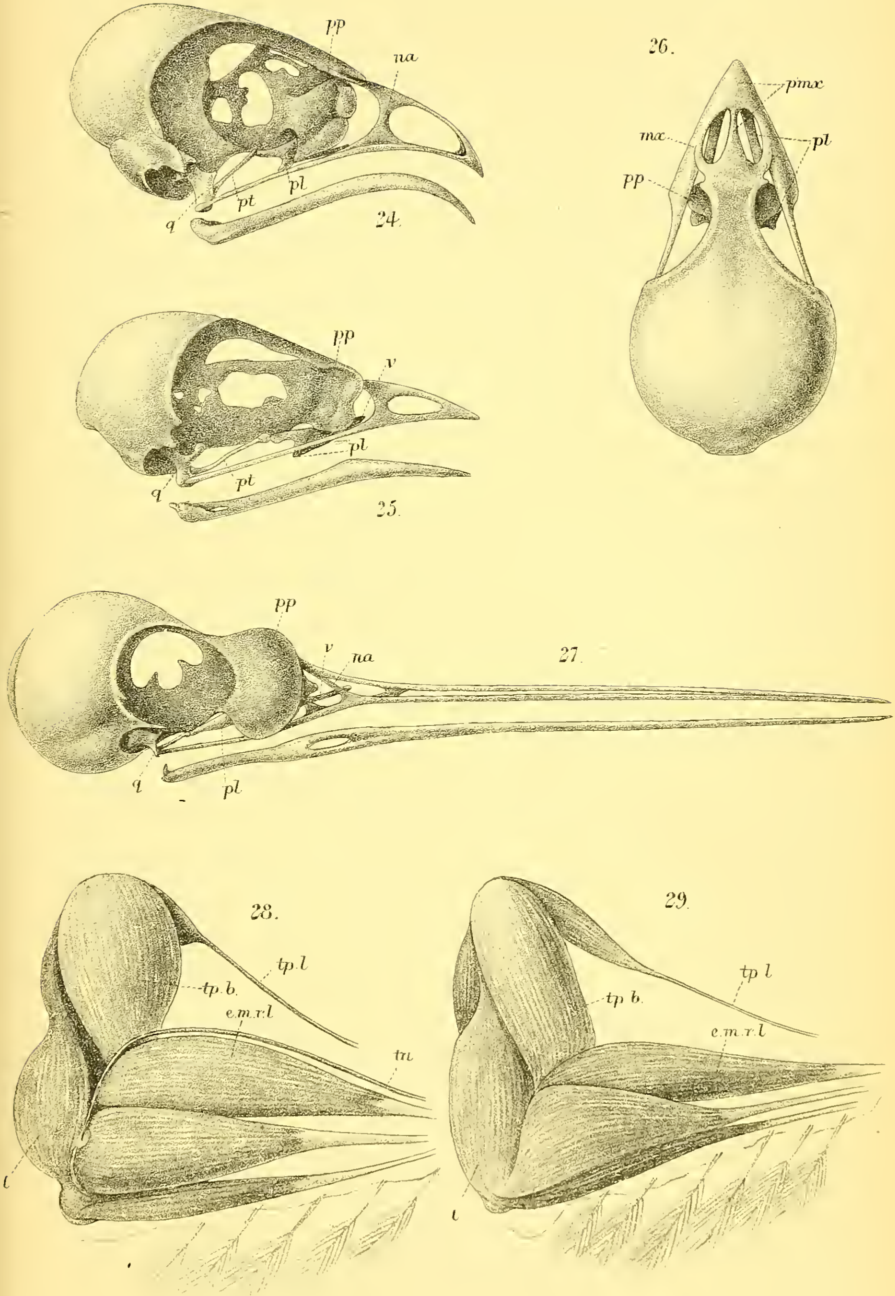

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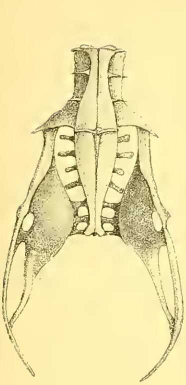

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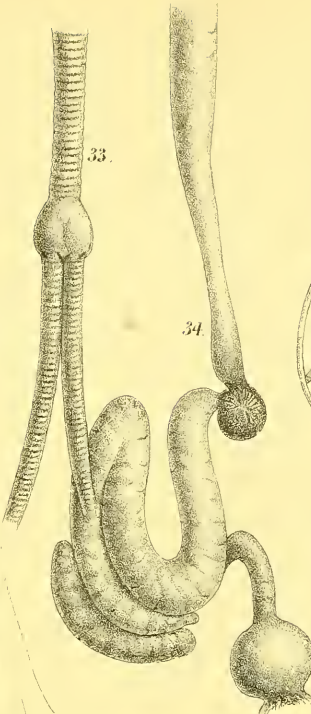
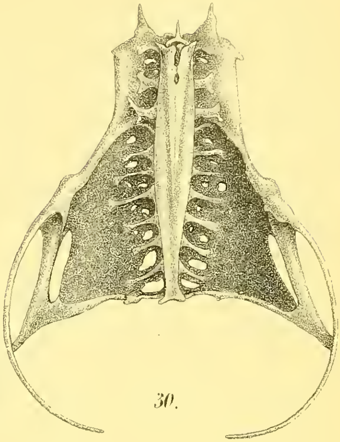


33. 34.



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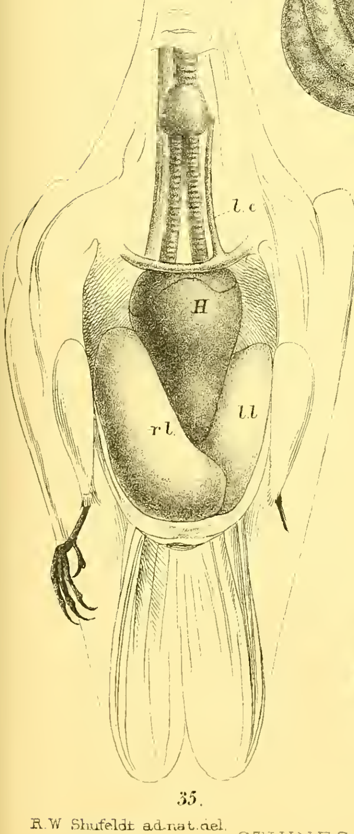

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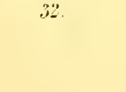

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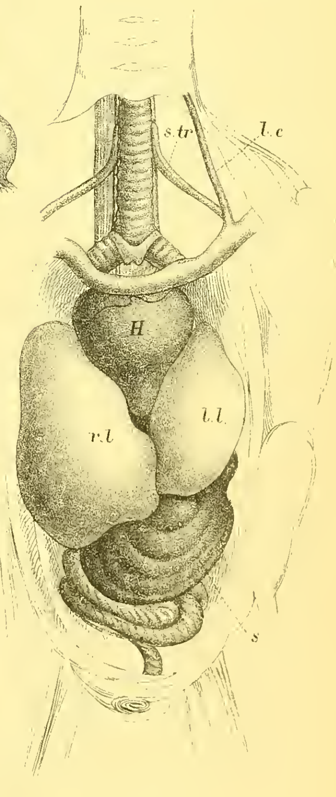

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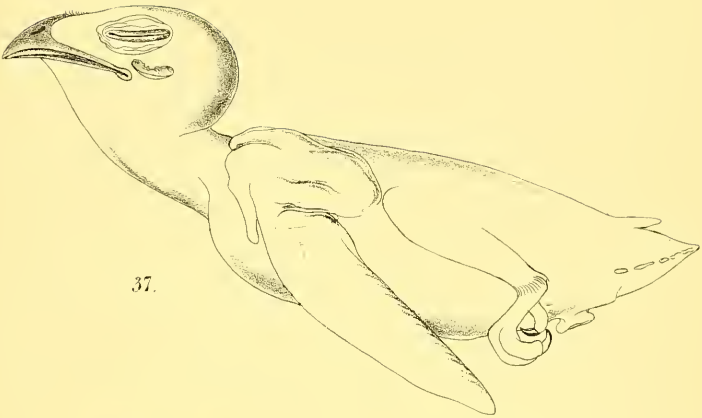

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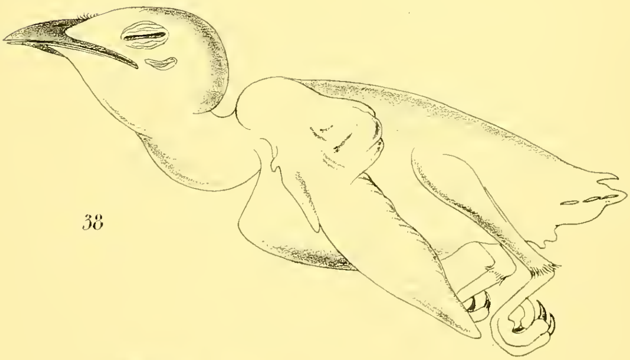

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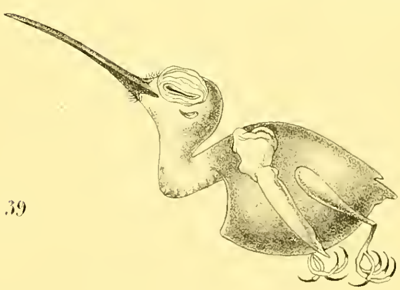

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